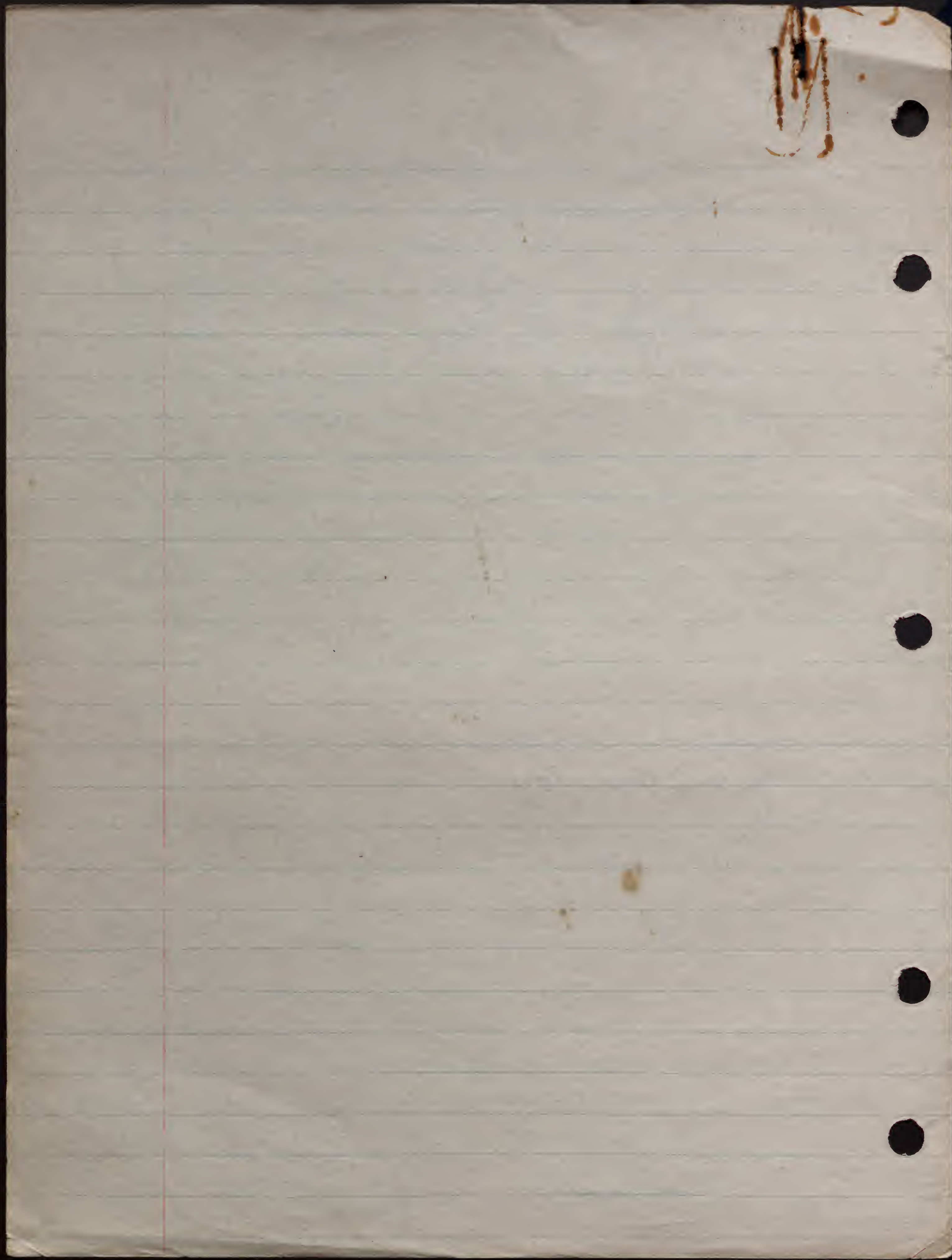


XI

Individ. for displays



March 9, 1944
San Blas

Anchored off Halunega at night. Running new light.

Ca. 7:20. Single Dory shows up. Pale. Leaves immediately. Some more inds. later. SAN

March 10, 1944
San Blas

Sunny and windy this morning. Going to start at Halunega. Arcadio starts shallow tow 8:00. All around island nothing. Then along off shore ridge 8:25. Find group of 30-40 young Sepiots. Mostly smalls. A few small-mediums. 2 ft up in 3 ft of water over TG. In usual pattern(s). Ord +. Quite calm. Quite close together. Some inds. have elongated tentacles. Feeding ?? On copepods? There are Spotted Goatfish swimming about below. There also is lots of miscellaneous debris in the water, including Sargassum. The squids do not seem to pay any attention to the debris.

I swim away and find another semi-detached group of small Sepiots about 20-30 ft away. One ind. is in extreme HD, with extended tentacles (tips of tentacles - the clubs - are conspicuously dark). Plus extreme Bar above and below. (Ross says that other inds. in group have been doing V's, splits, etc.)

Get out of water 8:45 am. A resumes shallow tow. Out

Ceph., Mar. 10, 1974, II

(464)

to shallow bank. Nothing. Stop 8:45.

Go on to Matupo. A shallow tow ca. 10:15. All around island, over to Alutupo, back. I do some swimming myself. Still nothing. Stop ca 11:15 a.m.

Go on to Salado. Now it is cloudy but still windy. A shallow tow along string of islands. Over to Jorgetupo. Around island. Back to another island near reef. 3:30. Find 4 Sepiots. 2 ft up in 20 ft of water over mixed coral and sand. Inds. are large or almost large. In Ord +. One does E buoy. Then relaxes. All 4 inds. assume Y when they drift close to us. Notice that at least several of the inds. have WCA and trace of Spade. During next few minutes, at least two of the inds. do several Curls and E's. All in Ord +. No trace of courtship. (Are Sepiots more likely to perform such patterns as E's and Curls during the non-breeding season? Possibly because they have nothing else to do ???)

Inds. in Curl (possibly also in E) show a definite tendency to swim away from the group as long as they maintain the posture(s). Could this be "distraction display"? Or enticement?

There are Gray and Yellow Goatfish swimming nearby.

A goes in to take photographs. The squids retreat. Some DM in Ord + during retreat.

Then I get out of water. A resumes tow over TG flat. Finds group of 10 small Sepiots. SAN

We stop observations 4:25 p.m.

COMMENT: The water has been very cold everywhere today. Is this one of the reasons why we have seen so little of interest?

Ceph., Mar. 10, 1974, III.

465

Go back to Pico Teo in evening. Run light. Some sep
lots and one Dory show up. SAN.

July 17, 1974
San Blas.

Arrived last night.

Run light off shore Nalunega. One medium (large?)
Sepiot showed up. Fed actively on very small organisms. SAN.

Start out at Matupo in morning. Sunny. Windy. A
starts shallow tow ca. 9:30 am.

Finds 16 small Sepiots almost mixed. High in 3 ft of
water over TG flat. In Ord + WS + PCA. Also Pointing down.
The two nearest inds. do Forward V's. Then one does Split.
Both probably in Double streak at the time. Then all inds. relax.
Sink lower. All in Ord +. Still Pointing down. Tentacles some
what extended.

Then there are more V's and Splits when A approaches to
photograph. Displaying inds. clear below. With some Fin stripe.
Probably also Double streak. Inds. retreat. A follows. I get out
of water. A stops observations 5-10 min. later, ca. 9:45-9:50.

NOTE: This area looks eminently suitable for a "nurs
ery." But I think that this may be the first time that we have seen
young Sepiots actually using it.

A resumes shallow tow. 10:00 am. Area of reef on mainland
side of island. Finds group of large to medium large Sepiots. Pro
bably at least 16 inds. in group as a whole. More or less divided into

Ceph., July 7, 1974, II

466

3 subgroups. 4 inds. in nearest subgroup. 3 ft up in 12 ft of water over mixed coral and sand. All in Ord +.

There is a large Gray + Yellow Goatfish just below this subgroup. Feeding peacefully on or near bottom. The squid drifts along and the Goatfish definitely follows.

The largest ind. of the subgroup shows brief trace of Pie. All inds. swim away rapidly. Without much color change but possibly mildly alarmed. Interesting thing is that retreat upward. Very near to surface. Surely this is unusual ???

One ind. approaches sardines. Extends arms and tentacles forward. But does not strike. NOTE: Most Sepiids are really very cautious about striking at large prey.

Then all inds. sink low in water again. Several do E's. Why ??? All still in Ord +. Then the largest ind. does Pie in ordinary swimming posture again. No response. Back to Ord +.

Subgroup drifts inchoe, then out again. Joined by an other subgroup (at least 6 inds.). Some inds. do E and/or Point Up in Ord +.

One ind. suddenly dashes at fairly large fish. In Yellow-ish mottled pattern with Point Up. Apparently "territorial defense rather than feeding. Fish retreats immediately. Squid relaxes. Back into Ord +.

Then same ind. does "Yellow" - Point Up to A when he swims nearer to photograph.

Another group of 4-5 inds. react to A's approach by sinking down to Staghorn Coral. Mostly tail to coral.

Ceph., July 7, 1974, III.

(4617)

All in Ord+. Some do Point Up. This is very reminiscent of young at anchor lines. Obviously cryptic and/or mimetic. These inds. leave staghorn and drift apart when A leaves.

A few minutes later, I drift over 4 or 5 other inds. All turn "Yellow"-mottled - Ord+ One with trace DM.

COMMENT: I think that "PH", "Yellow", and "Yellow mottled" may all be the same thing, or no more than variants of a single pattern or a single kind of intergradation between Ord+ and Z.

Then we all go swimming around Achutupo (Little Matupo) and wreck in channel. Nothing of interest.

Stop 11:40 a.m.

This afternoon we go to Panetupo. A tow back and forth in front of Panetupo, then around Piriatupo, then around Quiriquintupo. David and I swim from time to time in various places. All ca. 1:45-4:00 p.m. Water usually very murky. Obviously the weather has been disturbed for some days. Wind still strong. We do not see much of interest. Only some blobs of ink near drift line over deep water in front of Panetupo.

Running light from boat at Panetupo at night
SAN. (One ind. Sepiet. One group Dory).

July 8, 1974
San Blas

Still at Panetupo.

Ceph., July 8, 1974, I.

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A starts tow around usual areas 7:40 a.m. Sky overcast. More or less calm. Water clearer than yesterday. We go back and forth. No luck. Stop 8:00 a.m.

Over to Pinnatops. A and O tow, beginning off shore (point) reef. A sees young Sepiots almost immediately. In shallow water, TG flat. The young fly away, disappear.

We all swim around looking for them. Then C sees some near boat. We rush over. Find 3 medium Sepiots. Halfway up in 3 ft of water over TG flat. All 3 in more or less Bar (NOTE: Bar in low water), with more or less Fin & stripe and/or trace of Strake(s). One ind. does superb Contort. Come c.c.:



Posture perhaps not as symmetrical, but possibly even more exaggerated.

These 3 inds. dash away. We follow after. Then we come across a group of approximately 40 inds. Ranging from small to medium (quite smooth gradation), plus one semi-large. Half way up in 5-6 ft of water over TG. Quite close together (6"-2' apart), strung out more or less in line. All more or less in Ord+. Drift away into slightly deeper water,

Ceph., July 8, 1974, II.

(469)

then back into shallows. Group seems to be relatively tame (for young). Not greatly disturbed when A photos. (Only a few do Fin Stripes and/or Double Strialis when he comes particularly close.)

COMMENT: This certainly seems to be the nursery area for the whole group of islets now.

We stop observations, and A and I resume shallow tow.

A few minutes later, A finds 2 large Sepiots. Really quite close to where young seen a few minutes earlier. But bottom here is mixed sand and TG with lots of isolated coral heads. When I get into water (rather tardily) the 2 squid are 2 ft up in 4 ft of water. Engaged in full "Courtship" with copulation attempts. Very energetic. Conventional in some ways. Pair rocking together. Male makes many pines. He is usually in Pastel during pines. Much fluttering. Female usually responds by shooting upward and backward in Pic.

There are also some points of interest. Female frequently shows conspicuous Belly-spotting (Speckled Belly) during and at height of rise. This must be visible to male following below. Spots quite large (at least as large as when Belly-speckling is combined with Z by ♂'s). This pattern must be "repellent", probably purely hostile. The ♀ never did Z with her Speckled Bellies this morning. At least once she was Pic on top when Speckled Belly below. Several times, she was PH on top. (NOTE: these PH's were not particularly yellowish. There is a real difference between "Yellow" and PH.)

The male sometimes showed Fin Stripes and perhaps

Ceph., July 8, 1974, III.

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traces of Double Strike, superimposed upon Partel and Flutter, when making a pass. But the passes accompanied by Stripe and Strike probably did not lead to actual "strikes".

There were, however, quite a lot of strikes at various times. At least 17, possibly many more. Some or all apparently successful. The ♀ does not "arrange" spermatophores while I watch her, although she does "twitch" tips of tentacles after one strike, and A saw some arrangement later.

Then both inds. relax. The two inds. swim together, about 2 ft apart, in Ord+. A goes in to photo while I get out of water to write.

A few minutes later, a third ind. appears, presumably another ♂ trying to get at ♀. A dispute develops. SAN (First ♂ 2 at first. Then Lateral Silver, while second ♂ is still nearby, continued after 2nd ♂ leaves.)

Stop 9:05 a.m.

Go out again 10:00 a.m.+. Over to Piriatupo again. Sun now shining very brightly. Only light wind. Go straight to area where pair (and extra ♂) found earlier this morning.

Find single large Sepiet immediately. Low in 3 ft of water over TG, sand, coral. In E and Ord+. Retreats into deep ex water. Then see pair, about 10 m. away from place where first ind. seen. These are obviously the same 3 inds. seen earlier this morning. Pair are in Dark. Little or no WS at first. Then one shows more WS. Same ind. also assumes semi-HD.

I break off observations for 5-10 mins. Then back to pair. Still there, in same place. And now third ind. presumably

Ceph., July 8, 1974, IV.

471

same "intruder" ♂ is about 10 ft away. All in Dark. "Intruder" also in E. One of pair approaches us. Goes out of Dark, into Ord + WS + Y as it does so! Then retreats. Goes back into Dark!

Then there is a sudden burst of displaying. I miss the exact beginning. When I catch on, "intruder" is 20 ft away from pair. He is in extreme Bar and Curl. (Again Bar in shallow water!) Also DM on at least one side (on body?). Presumed male of pair is in extreme Lateral Silver. Light side toward "intruder" as would be expected. Female of pair is in peculiar extreme asymmetrical "RL".

This is probably "incipient"

Lateral Silver. The only time that I have seen a ♀ do anything of the sort. Greatest extension of light on side toward "intruder" (The positions of the 3 animals were quite conventional. The ♂ of the pair was between the "intruder" and the ♀. This means, of course, that the incipient Lateral Silver of the ♀ was directed toward her own "mate" as well as toward the "intruder." Doubtless this aspect would not in the context.) Joint "defense of territory" ???

"Intruder" leaves almost immediately. Apparently, actually "repelled" by Lateral Silver. Lateral Silver seems to be very high intensity and effective threat.

NOTE: It seems to me that today's observations suggest very strongly that Bar is either higher intensity and/or contains relatively more escape, than Streak (on the average).

Then we stop observations of these animals. Go on a

Ceph., July 8, 1944, V

472

hundred m. or so, find an octopus. Almost certainly vulgaris. When first seen, it is in very shallow water (perhaps no more than 1 ft deep). On bottom. In TG. A few inches from sand of beach. A large bluish crab claw protruding from under web. I.E. these animals hunt by day.

I Animal is in reticular mottled dull "cryptic" pattern. More or less greenish gray. Large erect tubercles on back. Arms in apparently unritualized positions. All very reminiscent of Packard and Sanders. Animal is apparently "trapped" (see below) cut off from its home. Does not move.

II A and O start photographing. A nudges the animal. It immediately changes color. Goes Paler, still with some trace of mottling (and possibly papillae). And gets "Side Streak." As in A's photos of capture inds. in Lab. Streak on only one side. The side actually nudged first. Streak color dark Brown. Strong, dark, and clearly defined on face, in front of and under eye. A little irregular blotching above eye. Continuation of streak along side of body is sort of vague and irregular. Probably does not reach all the way to the rear tip. Arms are still in unritualized positions, but now definite, Barred.

Animal continues in this way for some time. Gradually cooing out to, or trying to reach, deeper water. Keeps side streak on same side, even when surrounded and approached from other side!

NOTE: Eyes seem to be raised on stalks through out this period.

Crab claw also continues to protrude throughout

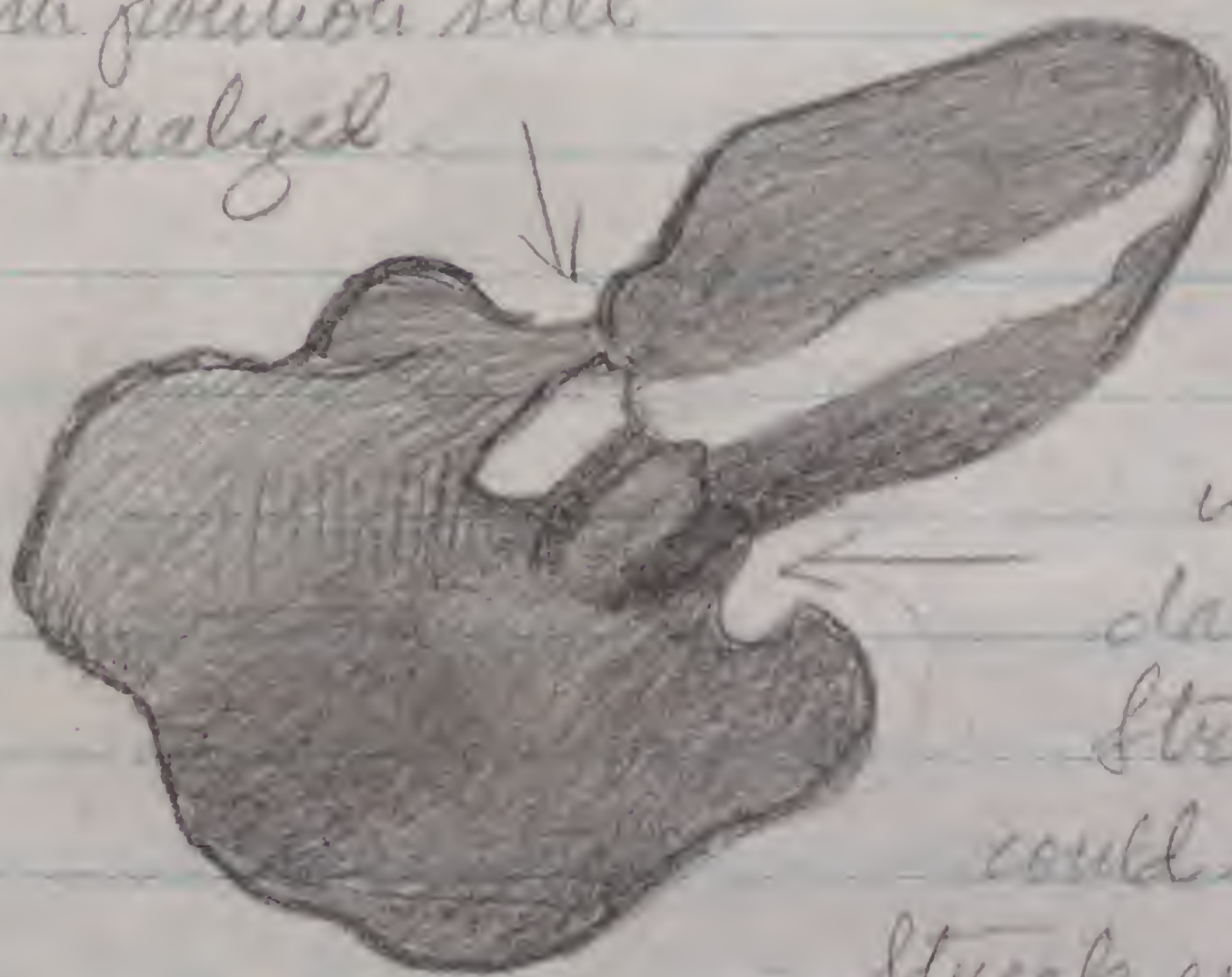
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(473)

IV Then, continuing to retreat, animal suddenly adopts "Light Streak". Most of body, and visible parts of arms, become dark brown. Except for a stripe of very pale color, probably almost white, over one eye, continuing backward down center of back, or possibly diagonally toward other side. Definitely "skewed". *Commence*

Arm portion still
unritualized

Possibly still with
papillae



The eye that went light was not the one that was dark in the preceding Side Streak. In actual fact, one could still see a trace of Side Streak even during the Light Streak. Almost as if Light Streak and Side Streak were extremes of the same coin — or at least extremes of a continuum.

IV Then the animal starts to retreat much more rapidly. Still crawling. But with arms and web fully spread. Portion highly ritualized. Animal generally very pale all over. Except for dark over eye (this time same eye as in Side Streak), spreading in fan over adjacent part of web between arms. Skin probably smooth throughout. No papillae. More or less *commence*.

Ceph., July 8, 1974, VII

(474)



VI Then animal suddenly shoots away swimming by jet propulsion. Usual vulgaris swimming posture (i.e. compare with macroopus). Entirely Pale throughout. Apparently no markings of any sort.

+ VII Animal continues to swim rapidly. I can't follow it, as I am in boat. But O and A swim after it, taking photos. It goes through several more color changes. Cryptic by rock or coral. Brick red flush just before darting into hole or den. SAN

COMMENT: This octopus obviously was hunting far from home. Its den is at least 10-15 m. from where we first encountered it. Presumably a permanent den. Shells scattered outside.

I come back to ship ca. 11:45 a.m. O and A continue swimming and towing. Find more young Sepiots around Pinnatupo. SAN.

We go on to Egumukip in afternoon. Still fairly

Ceph., July 8, 1974, VIII.

(445)

calm but now overcast. A starts shallow tow around island. Beginning usual side. Then out along reef. Ca. 3:30+. Sees group 4-6 medium Sepiots. Large *Borracuda* appears and the squid disappear instantly.

Later on, near tip of reef, we find at least 17 Sepiots. More or less in line, 5 ft up in 10 ft of water, over reef, large by staghorn. 6-7 of the inds are only medium. The rest range up to large. Two different inds. do Pic.

Watch one courting pair. Rocking, backward dashes, ♀ in Pic, ♂ in yellowish version of Pastel with much fluttering. Several passes. Then one stridie. Apparently successful. Both animals drift off in Ord+.

Watching other adults and semi-adults in line a few minutes later. Occasional traces of Lateral Silvers, Partits, more Pies. But all very faint and sluggish.

A resumes tow. We go all around island without seeing anything more of interest. Finish around 4:20 pm.

Running light at night.
Nothing.

July 9, 1974
San Blas

Still at Ogupukip. Cloudy and windy at dawn. Lots of *Sargassum* in water.

A starts shallow tow usual route 7:50 am.

8:02. Finds 3 large Sepiots in reef area, over staghorn,

Ceph., July 9, 1974, I,

(476)

associated with a great diversity of fish. In Ord+ Takeoff immediately and disappear. Later on, A catches glimpse of (another) large Sepioid. Bar, Curl, V. SAN.

Then find 3 more large Sepioids by point of reef. One ft. down in 6 ft. of water over mixed coral. In Ord+ Quite placid. Gradually drift out toward deeper water.

We swim around for a while. Stop observations 8:50 a.m.

Go on to Morpeptupo. Weather is clear, sunny, calm now. A starts shallow tow 10:30 a.m. First along shore facing main land (lots of TG), then around island (along reef), then over to adjacent Natupo. Nothing of interest.

Then over to long offshore bar or bank. A sees milk almost immediately. We all get into water and swim around. I come across group or sub-group of 21 small Sepioids. More or less in line. Halfway up in 3 ft. of water over sand, TG, and Diadema. All in Ord+. Very placid. Then I find another group or subgroup of 8 small Sepioids a few yards away. Behaving just like the others. A finds more small Sepioids in same general area. The whole group or cluster of groups may include 50+ inds.

Some of the smalls are fairly "large". Others are tiny. But none looks at all "larval".

This is (still) a good nursery.

We get out of water 12:00 Noon. A continues shallow tow along bank. Gets brief glimpse of 2 large Sepioids. Unusual habitat for them (?). Then over to boat.

Stop observations 12:30 p.m.

Then over to Narasandupipi. Sunny and windy

Ceph., July 9, 1974, II.

(4747)

now. A starts tow around island 2:30 pm.

Find 31 young sepiots almost immediately. About half way up in $3\frac{1}{2}$ ft of water. Over sand and stretches of some plant (I don't know what this is — it is brown and fleshy). All the animals are clustered close together. All in Ord + A swims in to take photos. The nearest ind. assumes Fin Stripe and Double Strike on back (leaving belly clear). Then relaxes, goes back into Ord +. A few minutes later, several inds. assume Fin Stripe - Double Strike when whole group panics briefly (apparently frightened by jack). When we approach the squid again, they string out in line. I.E. they are more nervous now than they were earlier. But still in Ord +.

We break off and resume tow.

A little further on, same environment. A sees group of medusae. They disappear immediately. Apparently frightened off when Carlos sets propeller in reverse! Is this hearing?

Then we find 14 young sepiots in similarly shallow water over sand and TG.

Go out along coral reef. Find group of large sepiots 2 ft up in 10 ft of water. More or less over "valley" of sand and coral debris between two patches of living reef (*Acropora* etc.) In Ord +. Do several E's and Curls. Then we see that all or most of the inds. of the group are feeding actively. On rather small green "sardines", assembled in huge schools usually slightly inshore of the position of the squids. And this feeding is accompanied by remarkably elaborate display behavior by the squids.

Ceph., July 9, 1974, III

(4148)

Watching one ind. Group of squids is fairly low, while sardines are near surface. One squid rises, backward, in semi-Pale (or Pastel - see below), with DM (certainly on fins, probably extending onto edge of body). Then suddenly darts forward and upward, shoots out tentacles, catches fish. Then drifts backward and down, resumes Ord + and eats fish (apparently very rapidly).

Then there is a sudden panic in the group. All dash back a few yards. All turn Pale. Then relax. Resume Ord +.

One ind. does E and then DF in Ord +.

Back to feeding. Again approaching sardines from below. One squid swims diagonally backward and upward. With DF, in Pale, with DM (as before), Fin Stripe, and BB. Then suddenly shoots out tentacles (forward or slightly sideways). Catches fish. Swims forward, sucks, relaxes, resumes Ord +. (NOTE: The belly seemed to be clear throughout these displays)

Then see more feeding attacks. All with preliminary DF, Pale or semi-Pale (Pastel), more or less DM (on fins and/or body), and definite BB. Tentacles usually extended just before strike. When and if so, the main body of the arms and tentacles is dark, but the tips of the tentacles are whitish (could this act as a lure ???).

COMMENTS: These semi-Pales seem to be indistinguishable from Pastels. I.E. Pastels are only low-intensity Pale. The difference is quantitative rather than qualitative.

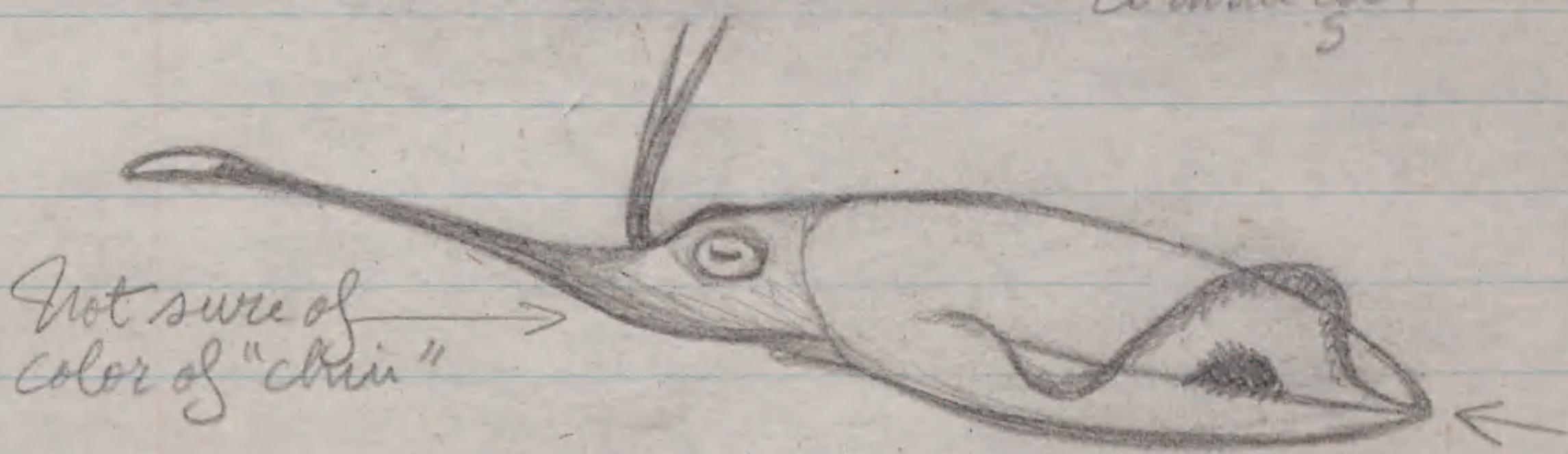
All or most of the DF's are extreme, but straight up.

Ceph., July 9, 1974, IV.

(4179)

rather than recurved.

General effect more or less
common ca:



Perhaps of fin -
stripes also are
varied. But I
doubt it.

See one Pie by one non-feeding ind.

Then back to feeding again. Strikes at sardines
always preceded by display. More or less as above. (I am not
sure that I saw strikes by more than 2 or 3 separate inds.
But A says that all the members of the group were behaving
in essentially the same way.) He also thinks that the fins were
usually or always held up just before a strike, SAN.

Sometimes a squid performed even more elaborate
displays while approaching a sardine. Usual DF, Pale or
Pastel, DM, and BB. Plus Curl (an exaggeration of DF?)
and/or E. But I think that these approaches were "inhi-
bited". They did not usually lead to an actual or success-
ful strike. No capture.

We interrupt our observations. Come back in about
10 min. (ca. 3:30 p.m.). Same squids in approximately same
place. Not feeding at the moment. A large school of chub
(?) swims by. Squids dash back a few feet. All turn extr
eme Pale during retreat. Most also do E. At least one
also assumes "quadruple" DM. And one does Bar after
Pale. Then all relax. Back into Ord +

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(480)

COMMENTS:

This is good evidence that E is quite high intensity alarm.

DM obviously is complicated. Can be on fins and/or body. A saw one "quadruple" in which the rear "eyes" were visible only from below, not from above.

Then a single Charax ruber swims by. All the squid dash away. I don't see the display.

They come back almost immediately. All in Ord+. Start feeding again. More or less as before. See some low intensity approaches. Only DF, BB, and slight trace of Pale. Some of these approaches are successful.

Then more approaches with E's and Curls.

A takes photos. I get out of water.

A resumes tow. Far side of island. Finds 45 (!) large Sepiots. 2 ft up in 15 ft of (murky) water over sand between reefs. At first in line. Then gradually "break up". All in Ord+. Then see some Pies and other signs of courtship. One ♀ is being courted by 2 ♂'s. She is noticeably larger than either. The "alpha" ♂ follows her closely and makes repeated passes. The "beta" ♂ follows at a distance (2-4 ft). I don't see any actual copulations or fights.

There is a Spotted Goatfish below the group.

COMMENTS:

Sepiots are incredibly abundant here. Why?

A suggests that it is because this island is near Pedretipo with "McMurray's Calanus". Perhaps the predator fish have been

Ceph., July 9, 1944, VI.

(481)

hunted out?

The squids feeding today were surprisingly nervous. All their displays hostile. All or most alarm. They can hardly have been frightened of the sandwies themselves. Perhaps they were worried about us? Have they also been bothered by skin divers?

Running light at night. SAN.

7:30. 3 or 4 large Sepiots feeding close together. Some times only 1-2 ft apart. All catching lots of small fish. And yet there is absolutely no disputing among them. (The species is really remarkably good-tempered.)

Feeding can be incredibly rapid here. One squid takes 3 fish in 20 secs. or less.

NOTE: We have seen more interesting aspects of feeding here than anywhere else. Are the numbers of the local population particularly hungry? Simply because the population is so large?

NOTE: There are four large Sepiots around all evening. First feeding, then resting near bottom. When feeding in PH, DM, etc. Little or no Bar. Very few other inds. And the other inds come in only briefly after the "permanent" four have begun to rest. The others also sometimes in Bar. Does this suggest territoriality even at night? Do the four really "own" this area???

8:55 pm. Four have now, suddenly, increased to eight. Reminiscent of two sub-groups. Is this largely the group of 9 that we saw this afternoon?

Stop 9:05 pm.

July 10, 1974
San Blas

Still at Narascondupipi Rain early in morning
Then cloudy and windy. A starts shallow tow 7:55 am
Along near shore, over sand, TG, etc. Then out along coral
Immediately finds group of large Sepiots same place where feeding
group watched yesterday. Obviously part of same group. (Perhaps
also including four at lights last night).

By the time I get in water, animals are drifting inshore
into shallower water over mixed reef. Halfway up in 2-3 ft of
water. (Note: the swell is very heavy here now.) All in Ord +
A approaches to photo. All inds. drift toward surface. All
into Bar (above and below). Some do Curls and/or E's

Then they suddenly all dash downward in Dark when
2 Pelicans fly overhead (This is first definite reaction to birds
that I have seen.)

Then they go back to Bars when A approaches again.

At this point, the squids are 20-30 ft from nearest
school of sardines. Probably because we have been driving them be-
fore us. They eventually resume Ord + patterns and circle
around back toward the sardines. One ind writhes tentacles
without color. Several others make tentative advances toward the
fish. Again without color changes. But probably with some exten-
sion of tentacles.

Two inds. advance toward sardines (again). In
Ord + with trace DM above, Bar (2 main bars) below, tentacles

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(483)

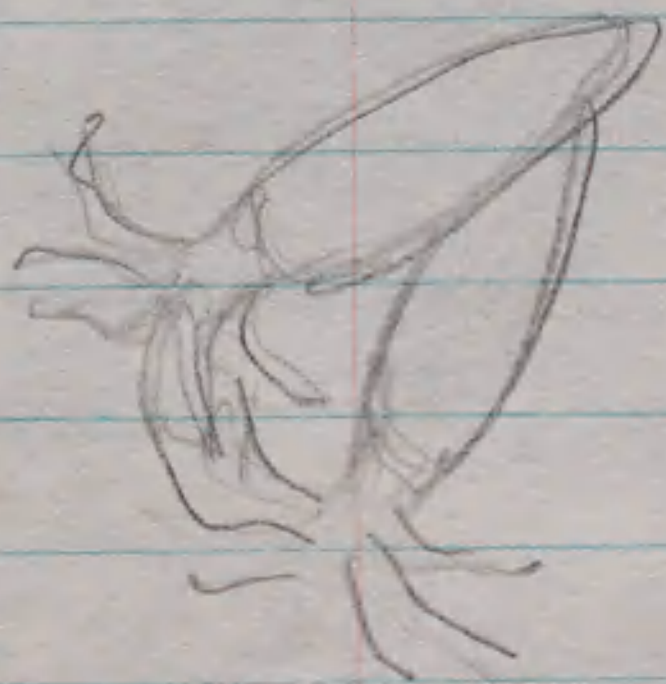
extended (tips conspicuously white as usual) No studies. Inds. drift back and relax. Then a third ind. advances (swimming forward) in extreme Pale and Curl, slight trace of Bar or Low. Then stops Curl, keeping Pale, extends tentacles, strikes. Apparently successful. Retreats backward. Relaxes. 8:15 a.m.

Then we disturb the animals by our movements. More Bar patterns. Eventually relax again.

Courtship. ♂ approaches ♀. She Pies. He is in Ord + with conspicuous RL. Then both relax. Swim together. 2nd ♂ (Beta) approaches. ♀ Pies again. Both ♂'s assume conspicuous Fin Stripes. Beta retreats. ♀ and Alpha relax.

Alpha approaches ♀ again. He is Ord + with RL and definite WB (white border fins). WB seems to be an extension of RL. Perhaps a high intensity version? ♀ Pies in response.

Then I turn around to find a dispute in progress right behind me. Don't see preliminaries. Two ind. tail to tail, partly croned, one over the other, in "usual" position. Commence:



Like many of A's photos

Both inds have extreme Spread. As usual upper ind is generally darker than lower. Upper is mottled, semi-transverse striped on back

(dark Z? or Ord + - PH - Z?) Conspicuous spots and/or bars on arms. Fin Stripe. (Upper border quite clear but lower border slightly speckled — this is not what I have been calling Belly-speckling or Belly-spotting — it may

Ceph., July 10, 1974, III

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be characteristic of all Fin Stripes — comme ça:

~~Two individuals~~) Belly itself is clear and pale.
Upper individual also WB
and (probably) RL. Bottom ind. has extreme Z and real
Spotted Belly. The two inds. maintain these patterns for a few seconds,
then drift apart and relax. Back to Ord +.

A few minutes later, see another encounter. Don't know
if it involves same or different individuals. Two animals swimming
apparently peacefully in Ord + several feet apart. Then one swims
purposefully and directly backward toward the other. Approaches
in Ord + with RL, WB, Pale tentacles, and Fin Stripe. Bumps
into approached (who may have been in Ord + all the time?).
Into flank, toward rear. Then slips below the approached.
In more or less usual dispute position. Does Z with Spread.
No Spotting on belly. The individual approached and bumped in
to, now upper, retains Ord + but assumes Fin Stripe. Perhaps
also does slight Spread. Then the two inds. separate and relax.

As far as I could tell, this was a quite unprovoked "attack". See also comments below. (Both inds. appeared to be ♂.)

Now all the inds. are swimming peacefully. Occasional
RL's. See Pie in distance. Some RL's accompanied by WB. Others
apparently not.

Back to feeding. Some approach intention movements with
simple Pale, probably nothing else.

Another "fight" in distance. As far as I can tell, it involves
only 2 inds. Lots of Z's and Spreads. Can't follow details.

COMMENTS: These animals seem to be remarkably quar

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relsome today. Why. Of course, there is some mild courtship in neighborhood. And some feeding. And we are disturbing. But at least some of the Z-experiments do not seem to be directly tied to any of these factors. Are the animals just "irritable" because of crowding???

Then there is more successful feeding with displays like yesterday. BB and all.

All calm again 8:35 a.m.

One ind. in Ord + puts arms back over head and seems to scratch upper back. Grooming? (A says that he saw another case of this earlier.)

Now I see that there are 8 inds. present.

One ind. in Ord + has had indication of black "collar" for some minutes. What does this mean?

I get out of water 8:40. A continues photos.

SAN. A has seen interesting incidents that I missed.

EG. ♀ in Pic "pursuing" ♂

Start out again 10:15 a.m. Weather unchanged. A starts shallow tow going around island in opposite direction from usual.

We get to area where 45 inds. seen yesterday. Find ink in water. We go into water. Find group of 43 Sepiots. Obviously same group as yesterday. But now I notice that not all the animals are fully large. Some are hardly more than medium. 2-3 ft up in 10-15 ft of water over sand "plain" between reefs. All in Ord +. None or less in line.

O sees courtship at far end of line.

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Animals gradually drift nearer to us. Turn Dark as they do so. Then retreat a few m. in Ord. Streak. Then go Dark again. Formation gradually breaks up.

There are several Spotted Goat fish near bottom below the squids. Seem to drift along with group.

Then I see courting pair. ♀ Pie etc.

Notice that nearest ind. of group, still in Dark, consistently has P.A. Is this indication of very mild alarm?

More courtship. ♀ moves backward in Pie. ♂ follows in Double Streak plus Fin Stripe. Then relax. Back to Ord+.

On the whole everything is very placid. Certainly no fighting here.

Stop watching this group 10:50 am. A resumes tow.

A little further on, he finds 2 large Sepiots in reef area. He is under the impression that one may have risen from hole in reef. Wonders if egg-laying is in process. When I get in water, the two inds. are 1-2 ft up in ca. 8 ft of water (bottom very irregular). Both in Ord+. Not very close together.

Then A sees copulation (I miss it completely).

Both inds. back in Ord+. 6-8 ft apart. After facing apart from one another, I note that ♀ is very much larger than ♂? Also badly scarred. Presumably old. Then ♀ Pies briefly when ♂ approaches. They separate again and relax. Facing away from one another again.

Then a large school of jacks swims by. Squid do not go away or at least come back immediately.

♂ suddenly approaches ♀ again. Swimming forward

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with Pastel Flutter. ♀ goes into PH (!) and RL. Then both relax. Swim in Ord+. Whole procedure repeated twice more. ♂ makes several bends during approaches but no strikes. Then both animals relax again.

This would appear to be a late stage of "courtship." ♀ is not afraid of or much irritated by ♂. But neither is she very interested or receptive. Presumably, she will lay eggs soon. But she does not seem to be preparing to do so now.

Continue tow 11:18 a.m.

A finds group young Sepiots in TG flat. They disappear immediately. We go on back to boat.

After lunch, A goes back to check on single pair. Apparently gone 2:50 p.m.

Go on to another small (but heavily populated) island: Mornakatupe. A starts shallow tow 4:10 p.m. Goes around whole island, over Eelgrass flat, sand, TG, coral reefs. Nothing of interest.

Back to Miatupo for the night. Running light. First Sepiots show up 7:18 p.m. Feeding in Dark. Halfway up in water. (Depth here is ca 10 ft.). Go away again almost immediately. I.E. not "territorial" here??

Aha! Back again 7:25. On bottom. Feeding with arms raised, Ord, DM, etc. SAN. Then go off after a while. Stay away for at least sometime. Back again by 7:46 p.m. Perhaps territorial after all?

First little Sepiot shows up 7:50. High in water (while 2 larger remain near bottom). Little one probably in

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some sort of dark (4-) Bar with Y. Apparently fading on tiny, tiny organisms. Then little one goes away.

Two large Sepiots still present 8:12 p.m.

Presumably only large inds. are territorial.

Then 2 very small squid come in brief. 1" and 1 1/2" ? A thinks that they are semi-larval Sepiots. But they had very peculiar patterns. Dark stripe down center of back and DM. Dark triangular blotch on back. Very remarkable for Sepiots!!! Could there be inds. of another species? Could they be *Pickfordiatus* ???

9:01. A catches a small squid. Possibly slightly larger than the larger of the two cited above. Definitely Sepioid.

Several more large Sepiots around now. All in Dark sort of the time.

Stopping 9:32 p.m.

July 11, 1974
San Blas

Still at Halumega in morning. Rain and wind. This continues almost all day. Some bad storms. Starting at 9:25 a.m., we look for squids all around Halumega itself, the offshore reefs, the adjacent islands of Orpiski and Mamutupo, their offshore reefs, and Michucala. See some ink but only a few groups of Sepiots:

① 10:40 a.m. Reef offshore Halumega. A sees 8 mediums. 4 ft up in 15 ft of water, edge reef. Do Bar's, V's,

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Curbs, etc. We do not stop to observe them because of particularly bad storm.

② Ca. 1:30 p.m. A finds 4 mediums or medium-larges near Orpisiki. When I get to them, they are 9 ft up in 12 ft of water over sand and coral. In Ord+. Very plain. There is a Gray + Yellow Goatfish below them. There also is ink in the water. A photos ink.

③ Off Wichuvala 4 smalls in 4-6 ft of water over TG flat. Disappear. Perhaps go down into grass ???

Anchor in channel off Pico Feo in the late afternoon. Calm here. Rain stopped for the moment. Going to run the light.

SAN. First Dory appears ca. 7:15. Another Dory 8:35. Possibly one more later on.

July 12, 1974
San Blas

Go to Soledad Mandinga in morning. Cloud with some sun coming through. Fairly calm.

A starts shallow tow 9:05 a.m. Water murky. Sediment from Rio Mandinga after rain. Go around whole island without seeing anything of interest. Then go on to adjacent island of Nuntupo. Start tow around.

A sees ink. We swim around. Find group of 40+ Sepiots. Halfway up in 3 ft of water over TG flat. All in line. Ranging (smoothly) from medium to large. Nicely graded; the small

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est at one end, the longest at the other. All in Ord +. Very placid. Gradually drift out into deeper water. 9:40 a.m. Now 2 ft up in 12 ft of water. Still to bottom. Some Gray & Yellow Goatfish around. Then some Spotted Goatfish. The squid gradually drift further out to area of sand and coral.

We stop observations and resume tow.

9:57. A sees ink blobs over another to flat. We swim around for some minutes without seeing anything of interest.

Then A discovers 2 large Sepiots. When I catch up with them, they are 15-18 ft. down near steeply descending coral reef. Edge patch of sand and coral. As it turns out, these inds. form a "pair" of obviously prospecting for "nest site." Copulatory phase completely over. Egg laying not yet begun. We follow these animals for ca. 1 hr. During all this period, their behavior remains much the same.

Generally calm and slow. Usually swim 1-4 ft apart from one another. ♀ considerably larger than ♂? It is she who is setting the course. Most of the time she is ahead of ♂. Even when ♂ appears to be in front of her, it is obvious that he is reacting to her moves and swerves of direction.

At first, the 2 animals stick closely to one general area, possibly 10-15 ft in diameter.

♀'s behavior is characteristic and stereotyped. She is almost always in Ord +. Very frequently in E (see below). Usually swimming forward. Then, every once in a while, she would approach reef, apparently a hole in the reef. Usually coming out of E at same time, and letting arms and tentacles go

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go straight forward. Probably extending tentacles at same time. Probably also moving arms and tentacles slightly in other ways (perhaps some spread at bases) She would then "hang" for some seconds - perhaps even a minute or more - and then resume swimming, usually in E as before.

As far as I could tell, the ♀ never actually entered a hole. But she certainly "visited" a dozen or more.

The ♂ accompanied her as best he could. Sometimes swimming forward, sometimes backward. Relative positions apparently unitalized. He sometimes was in undistinguished Ord +. More often with more or less Bar. (Reaction to us or to passing fish?) He also assumed a few E's on occasion, but never with anything like the frequency or persistence of the ♀.

A saw some other minor color changes. SAN.

The area preferred by these animals at first contains some Agaricia. But not very much. A believes that the ♀ concentrated her attention upon the available Agaricia. But she must eventually have decided that the area was not quite good enough. She started to travel away slowly and more or less methodically. Covers at least several hundreds of yards.

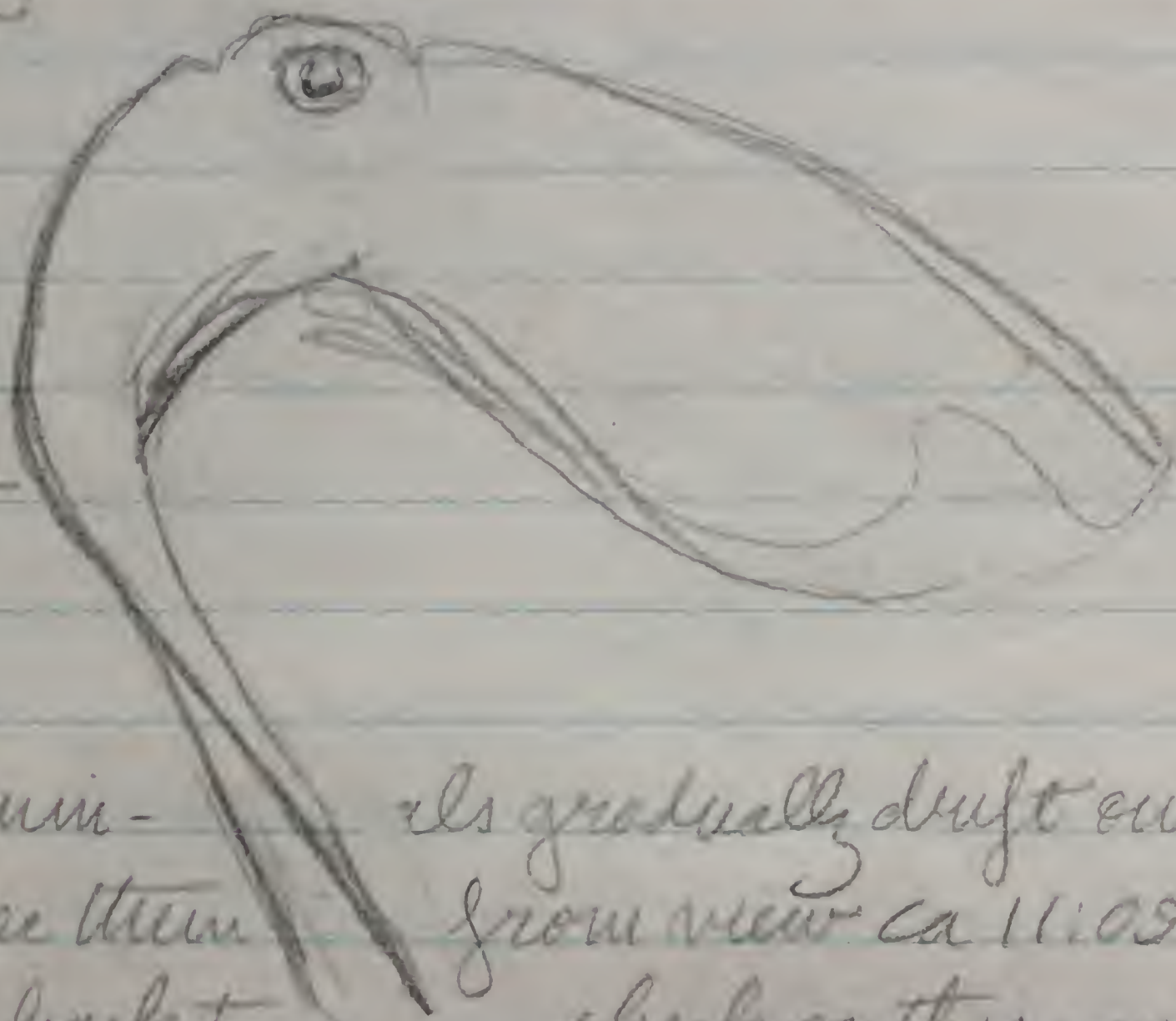
We eventually lost sight of the animals. Visibility is low here. Murk. Also turbulence and refraction due to mingling of waters of very different temperatures. I imagine, however, that the animals continued to behave as before.

Obviously the selection of a site for eggs can be a prolonged process. But probably not very tiring. It does not consume much in the way of energy or resources.

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NOTE. The ♀ was in E so frequently that I thought that she might be holding a cluster of eggs in her arms (abraded). But later I decided that this was improbable. In all or most E's, the arms (or tentacles) project far down (not held against the body). The tips of the tentacles also were sometimes separated. Continue ca.



Both the E's and the Bars must be indications of real nervousness.

The arm-ers water. We lose them as gradually drift out into deep from view ca 11:05 a.m.

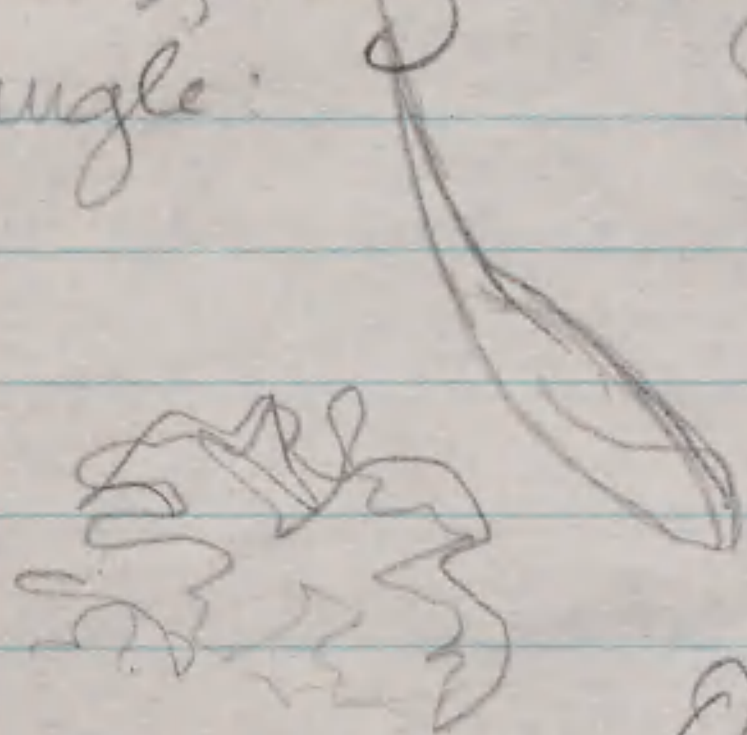
A goes back to check on this pair after lunch. Finds ♀ laying eggs approximately same general area 1:22 p.m. Sees 3 descents into hole (Mullepora? - check identifications). Near sand bottom, between 15 and 20 ft below surface. During one descent, ♀ appeared to be holding eggs in arms. ♂ present. We dash out to see. Arrive 1:30 p.m. Find ♀ hovering 1 ft up near hole. I don't see much in the way of details at first. But A sees ♀ make 2 more descents into hole. Also see ♂ still hanging around a few ft away.

Then I focus on scene. A swims away to get camera. By this time, ♂ seems to have disappeared. (Of course, he may not have gone very far away, but he is at least no longer within 10 yds of ♀.) And ♀ seems to have stopped laying. She

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hangs apparently exhausted, slightly above hole (2 ft above bottom?), body and arms pointed upward. More or less at this angle:



In a rather peculiar color pattern. I only see black. Very broad WS. Largely interrupted by 3 black smudges.

There obviously are indications of Bars. Rest of back generally as in

Ord (at least as far as tone and color are concerned). But traces of Bars also visible here. Plus double DM (probably extending to sides, but primarily on fins). Almost completely immobile while hanging. Only "jigs" slightly up and down. Obviously due to fin movements.

Then she swims away, disappears (perhaps stimulated by Bill Durham). 1:50 p.m.

A goes down, finds eggs, and collects them. We will take them to lab and try to hatch them.

NOTE: A finds black pomacentrid in hole in which eggs have been laid! This is beginning to look like real and highly specialized commensalism!!! (Question. Since the pomacentrids are so aggressive, why don't they attack the squid? Or do they? They certainly don't seem to bother the eggs.)

A must check to see whether there was a pomacentrid egg clutch that we didn't watch being laid.

COMMENT: Doubtless the animals were affected by our presence from time to time today. But I imagine that the general sequence of events was almost or completely "natural." There must be disturbances of one sort or another in the best of

Ceph. July 12, 1974, VI.

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circumstances.

SAN.

Then go over to Carti later in afternoon. Start shallow tow and swim 4:00 pm. Still cloudy now but very calm. Go around Tufila and then Yautepo. A sees 1 small Sepiot. That is all. We stop 5:15 pm.

Then take boat to channel near San Blas Point and Pico Jico. They have some sort of fairly direct access to open water. Place is called Maichubun.

The channel is supposed to be very deep.

7:16 p.m. Small squid swimming light. Presumably young Dory. About 1 ft below surface. All pale.

7:40 pm Two largeish squid appear on outskirts lighted area. Don't come in further. One does Curl. Both pale. Could these be Loliguncula? ??

7:46. Several moderately large Dorys low near whirling sandunes. With RL.

Then 2 large Sepiots. In half light. Rather low. Both in Ord+ and E C!). More E's and Curls when flash light played on them.

Then another Dory.

Sepiots still around. More Curls in Ord+ when disturbed by flash light.

8:13. Small Dory shows up. Curls with sandunes at surface. Generally bright orange red. Then turns white on flanks, leaving red center stripe, streaks sideways and catches fish. SAN.

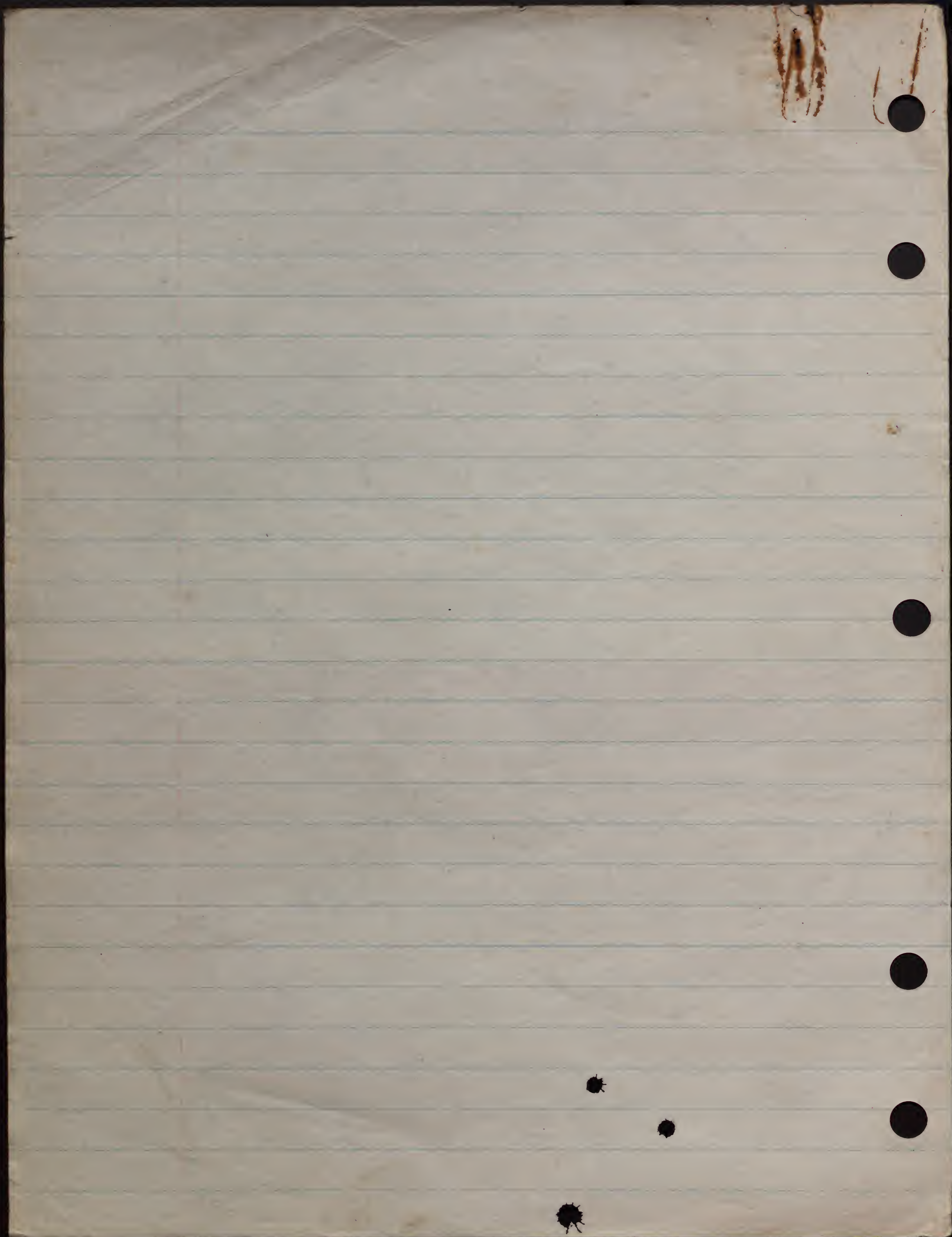
Ceph., July 12, 1955, VII

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8:20 3 large Sepiots and 1 large Doris swimming rather low. Sepiots in Ord. Doris pale. Then pale with C. Doris drifts away from Sepiots. Not numerous, a mixed school. A watches with mark. 3 Sepiots and 2 Doris. A says the Sepiots are really medium or medium small rather than large. Often in "blotchy" Bars. Doris pale. One does C as it swims away. SAN.

More Doris show up later, but population of the species still seems to be comparatively low.

Going to bed 9:10 p.m.



Ceph.

May 6, 1978

Arrive Naluneka late afternoon. Run lights at night ca. 4:00-7:00 pm. In fairly deep water. Nothing significant except 1 Dory SAN.

May 14, 1978

Naluneka. Weather fairly clear. Light wind. Very hot. Start out 8:15 a.m. A goes for tour of island. I swim back and forth dock side (I-III areas). Lots of fishes. No squid visible to me. A back 8:35. He didn't find any squid either.

We start another tour. A finds group of 14 squids in shallow TG. They swim out to deeper water. By the time I arrive, they are 1-2 ft up over TG in 10-12 ft water. All squids but somewhat various. Some very small. One is almost medium. Group gradually grows by accretion (2 by 2?). At least 20 inds by the end of our observations. Sometimes in line, sometimes a little scattered. Much of the time with tentacles semi-extended. Occasionally short advances. At least one flare. Perhaps actual feeding. If so, prey is very small.

All inds in Ord + most of the time. Ord + presumably is conventional. WS is wide. PA is wide. Bottom is light (definite). Fins are usually colorless. Perhaps with trace of indigo then WB? (A says that he saw some "PH" type mottling on fins, at least sometimes. But it must have been very faint or slight. Fins usually appeared to be quite transparent when viewed from the side.)

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There were a few brief retreats from time to time. In each case, 2-3 of the inds. assume Quadruple (with Fin Stripe) during the retreat itself, but then resume Ord + immediately as soon as retreat stops. (As far as I could tell, none of these Quadruples was "Quintuple" - i.e. with Belly Stripe. But I can hardly be sure of this.)

A saw one peculiar "asymmetric double" DM performance by one squid investigating sardines. SAN

There was a group of Spotted Goatfishes with the Sepiots. Association was prolonged and obviously "real" or specialized. Spotted feeding on bottom, usually 2-4 ft from squids. Probably 6 inds., approx., in goatfish group. Interestingly enough, the goatfishes were relatively small, not much larger than the squids. A suggests that this correlation of size is typical of the relationship! In the particular association seen this morning, it was difficult to tell who was following whom. I got the distinct impression that the squids were following the goatfishes almost (at least) as frequently as the reverse.

Also SAN for other aspects of relationships between Sepiots and grazers in general!

Get out of water 9:28 a.m. A does some more towing. Nothing more of interest.

Try again in afternoon. A goes towing around offshore islands (including Jaimupo) toward Pico Teo, 1:00 p.m. Nothing in the way of cephalopods. I get in water 1:20. Out 1:30. A continues tow. Still no cephalopods. A stops 1:45. (A says that there are a lot of big fish around now, including some enormous jacks, Caranx ruber. Perhaps they have eaten or chased away all the squids?)

Ceph: May 7, 1978, III

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Then we go on to Matupo. Start work 2:50 p.m. We explore all around Matupo, Little Matupo (Achutupo), and a small offshore island (Achutupipiwa?). No squids. I get out 4:15 p.m.

NOTE: There are a few pelicans feeding inshore on Matupo. Presumably on sardines. There also are some very large halfbeaks around.

A goes to tow Matupo once more.

Running light at night. In 12 ft water, white sand mixed bottom.

7:15 p.m. Not quite dark yet. Jack sees 2 large sepiots go by. When I get there, a few seconds later, there is only one large in sight. Swimming near bottom, in more or less dark — certainly no WS.

A few minutes later, small shows up at surface. Feeds repeatedly on tiny prey. Also makes apparently unsuccessful attempt to strike sardine. In Ord + (conspicuous WS) throughout. No trace of Bar.

Are there "still" daytime patterns???

Ram starts 7:25 p.m. We stop observations.

May 8, 1978

Still at Matupo. Weather is cloudy, rather cold. Start work 7:42 a.m. A goes for tow. Hunt around Little Matupo, then over to Big Matupo.

8:00 a.m. A sees single large squid. At first in fairly shallow

Ceph. May 8, 1978, II

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water over mixed sand and coral. Apparently carrying something warm. Eggs ??? Retreats into deeper water. Then suddenly disappears when Canopus ruber passes by. Reappears a few minutes later in Ord +. Retreats over reef in E, still in Ord +, back toward us. Could E be attempt to "hide"? Then disappears again.

A resumes tour around Big Triatipo. Nothing more of interest. We stop 8:30 am.

Go on to far end of Holandes Keys

A starts tour along Paratipo. Over large TG bed. Lots of debris and jellyfish in water. But no wind. Then tours over to offshore reef. Then over to Piratipo. Goes along point. Into TG area. I go into water myself.

11:25 Find group of small Sepiids. 60+ inds. (A says at least 145). At first 1-2 1/2 ft up in 10 ft of water over TG. Size of inds. varies. One or two almost medium. None is very small. (This may be characteristic of the period now.) When first seen, inds. are relaxed, semi-stretched. In Ord +. All floating horizontally. Then, as we get closer, they all tend to line up and gradually retreat. Several inds. in Quadruple during retreat. Then group splits up. One section apparently goes into deeper water. The (and other) goes into shallows. Includes 20 inds.

We find the latter subgroup again almost immediately. In 3-4 ft of water, still over TG. Inds "hanging", all in HD, just below mass of floating debris (Caves, eel grass, etc.) Most of the inds. are in Ord +. Both WS and PCA conspicuous. A few inds. at one end (near me) are more yellowish and tend to alternate faint traces of Bar and Strake (Quadruple?) patterns. These "Yellow" inds. have very conge

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cons. Y. So do one or two of the inds. in Ord +. But most of the other inds. in Ord + seem to have no Y at all. Then several other inds. begin Yellow-Bar-Stroke patterns. It all appears to be rather low-intensity. One ind. does real Double Stroke, definitely not Quadruple. Then whole group moves on. We do not try to follow.

COMMENTS: Yellowish probably is characteristic of all or most Stroke patterns (or at least Quadruples). And it is obvious, now, that HD is purpurine. Probably, in this species, characteristic of inds. floating beneath debris (or other shelters).

We continue swimming for some time without seeing anything more of interest. Stop 11:50 a.m.

NOTE: this is "nursery" area where we have seen many young on previous years. Area where O photographed.

Go out again after lunch. A starts tow around reef side of Peritopo 1:15 a.m. sees ink blob almost immediately but can't find individual responsible. Resumes tow 1:45. We find a whole mass of ink blobs over coral. At least several dozen. Some very large. All quite cohesive, filamentous. But again we can't find individuals. A resumes tow again. Continues around Peritopo, over to Guiriquitopo, to an offshore bank, and then over to Tactopo itself. Without seeing anything more of interest.

Finally 3:25 p.m. We find young in T₆ flat between Tactopo and Panetopo. 12-15 inds. When I get in water, they are 1 ft up in 2 ft of water. Mostly in Ord +, bodies horizontal or nearly so. Then several inds. do P₂, one does E. Without color change, bodies still more or less horizontal. Then all the inds. do more extreme P₂ as A approaches.

by the squid
↓

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closer to them, floating above them. Perhaps they also tend to sink down toward T₀ at the same time. They certainly tilt their bodies more strongly than before — front end upward — and assume various belly patterns. All or most of the inds. show broad bands of dark along sides well below Fin Stripe area. This might be called "Bottom Half of Quadruple". One ind., but certainly not the majority, also shows Belly Stripe ("Bottom Half of Quadruple"). A few seconds later, I see another individual with Fin Stripes and Belly Stripes, without Bottom Half of Quadruple. All the inds. seem to retain Ord + above, perhaps the Ord + is rather more yellowish than usual.

This behavior would appear to be remarkably sophisticated and purposeful. Perhaps a conscious attempt to be cryptic in the way most appropriate to the surroundings? See also below.

The squids and A gradually move on while I am waiting my notes. When I catch up, all the squids are in P again, with body tilted as before — possibly because A is still rather above them?

Then the animals gradually move away, backward, rising some distance toward the surface as they do so. I cannot follow the details, as A is photographing again. But they certainly HD as they rise. Then various inds. do Forward V's, Downward V's, and similar patterns. One does extreme split. A should have good shots of all of these.

Then we stop observations for a few minutes. Squids drift off. But we find them again. More or less half way up in water column of 5 ft. All in Ord +. We do not, this time, approach them very closely. Several do P₂ without color change, and with body semi-horizontal.

Ceph, May 8, 1978, I.

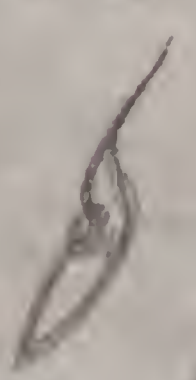
(17)

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One ind. does Fin Strobe in Ord +. Then several inds. do Downward P's and real E's. (Downward P's differ from HD's in that the body is kept more or less horizontal.) Still in Ord +. Then some inds. do HD's, also and still in Ord +. I notice that the tentacles are semi-elongated in HD. Is this typical of all HD's??? The inds. that assume HD are those nearest to me, and they assume the HD as I (inadvertently) drift closer.

Then I see several Curls in Ord +. Why? See also below.

One ind. shows brief DM, under fin, in Ord +.

One ind. near me goes Yellowish, assumes P with extreme body tilt , and shows Bottom Half of Quadruple or (more probably) Quintuple. Then relaxes. Goes horizontal in Ord +.

COMMENTS: Obviously this whole complex of patterns is very complicated indeed. All of the patterns may be primarily designed to baffle predators. Some are designed to be cryptic (uncryptic). Others may be effective because they contribute to aspect diversity. (Of course this is an oversimplification. The same patterns and combinations of patterns may work in different ways in different circumstances.)

All the patterns are alarm. Probably or possibly produced by relatively, not necessarily actually, weaker alarm than simple escape with Palung and/or Inking.

(1) Bars and the various Streak-Stripe patterns may be produced by much the same ranges of internal motivation. Which one(s) of these patterns are produced at any given instant may depend purely (?) upon external circumstances (or what the performing animal perceives or under

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(8)

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stands as the external circumstances) Both Bars and the various Streak-Stripe patterns seem to be designed to be cryptic, at least in inter-specific relations.

(2) Streaks and Stripes tend to be assumed against striped backgrounds. I.E. T.G. They are often combined with HD and/or P with body tilt. But the orientation is not always good. They are not infrequently assumed by inds. with body horizontal, perhaps especially before retreat.

(3) Bars are most frequently assumed by inds. caught in the open, in open water, and/or associated with floating debris, especially Sargassum. But there are complications. E.g. A, today, saw 2 swells assume Bars while sitting on bottom near bar-like alga. SAN. Incidents such as the last are our best evidence that the assumption of cryptic patterns is under conscious control.

(4) HD certainly is cryptic. Presumably usually associated with Streaks and Stripes (apart from Ord+). Presumably also usually associated with debris above.

(5) Downward P may be an intention movement of either HD or E.

(6) Simple Upward P can be an intention movement of a variety of rather different things: Forward movement. Upward Curl. Extreme P.

(7) Extreme Upward P (body very tilted) probably is the exact equivalent of HD. Also the mirror image. Designed to be cryptic. Usually with Streaks or Stripes, at least when low toward bottom.

(8) V's (including split). Cryptic. Often associated with Bars in open water. Also (less frequently?) with Streaks and/or Stripes in particular circumstances. Orientation of V's probably (also) under

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"conscious" control.

THESE ANIMALS MUST BE CALCULATING ALL THE TIME

⑨ Upward Curl and E (Downward Curl) seem to be rather different from the preceding patterns in some ways. Perhaps containing relatively less alarm. Certainly produced by a great range of intensities. Astatic rather than encyptic. Perhaps combined at "semi-random" ?????

Running light at night.

A few small-medium Sepiots show up. Nothing very interesting. But see SAN.

Also a single small Dory. About as small as any Dory I have ever seen (quite like small Sepiots in scale). Swimming at surface. Obviously feeding. On very small prey. Copepods or something similar. More or less dull gray-brown (Ord?). Silver eyebrows (X) conspicuous. Also "stripe" of iridophores down center back. Presumably equivalent of WS. This stripe is more or less conspicuous according to angle of reflection from light. Rear or subterminal part more often conspicuous than forward part. (This may be what we called "CL" in earlier notes.)

Then group of 3 Dorys, of same size, shows up. Circle under lights. All 3 also is Ord. Several times, group of 3 passes within a few inches of single ind. No visible response by any of the inds.

Are very young Dorys more scattered than older inds.? Like Sepiots? (But note that older Dorys are concentrated at night. Apparently unlike Sepiots.)

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(10)

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Then group of 3 Dorys breaks up, 2-1. A few seconds later, we see 2 Dorys (same, small, size) grappled, face to face or arm crown to arm crown. Looks like copulation, but it must be something else. Contest for prey ??? At the same time, we see that both inds. are generally "Red". Presumably hostile. Then the 2 inds. separate. Swim backward, back and forth, more or less side by side, for some minutes. Still in Red. "WS" not conspicuous. "Y" perhaps not conspicuous.

Of course, "Red" as a sign of high intensity alarm and/or invitation is well known in many species of cephalopods. What, if anything, is either the analogue and/or homologue in Sepioteuthis ??? Dark ???

Single Dory back again and again. Also group of 2 or 3 inds. ca 8:00-8:30 p.m. Lots of encounters among them which seem to be hostile. Some inds. in Red, others in Ord (+). These young Dorys would seem to be more (overtly) hostile to one another than are young Sepiots. (Or is it simply that these young Dorys are "equivalent" to "larval" Sepiots ???).

A sees another "grapple" among Dorys. One ind in Red, the other rather pale (Ord?). Then sees some swimming or chasing back and forth. He thinks that Red inds. tend to be more aggressive than non-Red inds.

Another single presumed Dory shows up ca 8:40. Feeds under lights in usual way. But apparently quite transparent, i.e. all chromatophores contracted. Only eyes and ink sack visible. A catches this animal. Puts it into bucket of seawater. It turns Red.

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more or less all over when first placed in bucket. Then starts to move around, bumping into sides. Turns transparent again.

Then we preserve it in formalin!

How many species of Loligo are there here???

7:25 p.m. A single very small (almost larval) Sepioid swims by light. In dark Ord+ (definite WS). Disappears immediately.

9:30. Still occasional "pairs" and trios of small "Dorops" swimming by. What are they doing?

NOTE: At one point this evening, a rather large Hammerhead appeared briefly.

May 9, 1948

Start out a Piratupo. A begins tow along reef side 7:54 a.m. Goes all around island. No squids. But lots of Barracudas of all sizes. Then we go over to Tiatupo. Begin tow from point of Tiatupo over toward Panetupo. I finally go into the water myself 9:03.

We find large group of Sepioids almost immediately. 1 ft up in 3 ft of water over TG flat. Group includes approximately 44 inds. Ranging from quite small to quite large. In diagonal line. Quite finely graded, smallest inds. (about 2 of them) at one end, largest inds. (about 3-4 of them) at the other end. Not many size gaps. Inds. ranging from only 2" to 1' apart.

The smalls and mediums are nearest to me. Most of them are in HD (even this low in the water!) In Ord+ (conspicuous WS and PCA, plus Y in many cases). One ind. goes Yellow, does extreme P, with

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strong body tilt, and Bottom Half of Quadruple to me. Orientation (showing lower part of body) is perfect and obviously purposive.

The largest inds. are at the other end of the line, farthest from me. A is photographing them. I can see that they are doing some E's.

Suddenly several of the smaller inds. near me go Dark. In P, HD, and horizontal postures. I see that the fins also are semi-dark, although lighter (or more transparent) than body. No real or well developed B visible.

Somehow one of the larger inds. drifts down to my end of the line. Suddenly does Pie! Extreme. There is no other large nearby. I think that this Pie must have been released by me. Presumably alarm. It was accompanied by slight retreat. Then the animal relaxes. Goes back into Ord+. Drifts back to far end line.

All of the smalls are in more or less typical Ord+ now. In semi-HD, facing me. I notice that γ is bright emerald green around edges. The fins are almost transparent, only lightly speckled with brown. At least one row of ocelli is visible on fins, along body.

I also get a chance to look at PCA and arrangement of arms and tentacles quite closely. Obviously quite variable. But the main dark part is provided by the tentacles. Center (upper?) shorter arms quite light. Also longer (lower?) arms. These latter probably account for the "spade" shape. Tentacles are probably always slightly extended in this context.



Several inds. suddenly go Pale and retreat (backward and hor

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ventrally) a few inches.

All very calm by 7:20 a.m. Group beginning to "scatter".

One ind. does Dark (no WS) with double DM (4 spots) in semi HD, apparently to me. Several others do semi-HD in Ord+.

None of the larger inds. seems to be showing any real courtship. (A sees a trace of Z, but this probably was a purely hostile encounter).

Suddenly one large with small or small-medium starts to display to me. In very complex pattern. Bottom Half of Quintuple below (I notice that side strokes continue out along arms). Sometimes 2 yellowish semi-PH above. At other times Ord+ above. Always with typical (2 spot) DM above. (As far as I can tell, the DM is not visible from below.) The animal alternates 2 postures quite regularly. One is extreme P, body very tilted. I think that I shall call this "Head-up", "HU". The other is horizontal, with arms forward, or even with rear part of the body slightly elevated. The first posture shows off the belly pattern. The second displays the DM. Everything very well coordinated. Designed to frighten and/or confuse me (again an element of aspect diversity). These little animals are clever!

Then all the inds. go very Pale. At least one Indis. And they all dark off and disappear. 7:28 a.m. Panic apparently provoked by group of medium sized Caranx ruber (Bar Jack). These jacks must be important predators!

Go on to Morpeptupo. Start work 12:36 p.m. A tow around Morpeptupo itself. Lots of Caranx ruber. Then we go out to the offshore bank. I go into water 2:00 p.m. We see some inds. and swim for some considerable distance. See a lot of sardines, but we can't find the squids.

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themselves. I get out of water and A resumes tow. 2:31 p.m. A finds group of ca. 30 small Sepiots, but they disappear immediately. After this, A continues tow all along bank, around Taptupo, and along reef between Taptupo and Xuijalatupo (this is large reef that continues to Salar. Without seeing anything more of interest.

COMMENT: The populations of *Sepioteuthis* seem to be low now. Presumably it is not coincidental that populations of predatory fishes (barraudas, jacks) seem to be high.

Running light at night (at Morpeptupo).

7:15 p.m. Group of approx. 20 Dorys shows up briefly, in deep water. Then disappears immediately. Reappear several times more. Always too deep to be seen clearly.

Then 4 small Sepiots show up. Not particularly close together. Apparently colorless. Drift off.

Then 2 small Dorys show up. Near surface. In "Ord." Drift off.

Large group reappears from time to time. Always low.

Then 6 small (& very small) Sepiots show up. Quite close together. Also apparently colorless. Connection; there may be 12-15 inds. in group. In line. Only a few inches apart from one another.

Is this the "post breeding season"? Have we missed courtship and copulation and the major die-off of adults ???

Then a single Dory-type shows up. Stays under light. Obviously feeding on small prey. Almost colorless. Yellowish white. No trace of either Ord or Red.

How many species of *Loligo* are there here ???

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8:08 crowded line of small Sepiet-like squids shows up again (?) just on border of illuminated area.

If these really are small Sepiets, why are they in a group now?

Again group of 4 small Sepiet types shows up. Again colorless. 8:26. One small-ish Sepiet and one small Dory-type show up more or less together. But then go separate ways. Sepiet certainly in Bar. Dory probably in Ord.

Single small-medium Dory comes in (again). At first Red. Then becomes colorless under light. Apparently feeding on very small prey (as before).

Group of small Sepiet-types shows up on outskirts. Apparently colorless (again or as usual). Then do V's and curls when flash light is shone on them. Perhaps assuming Bar as they do so.

Stopping 7:00 pm.

May 10, 1978

This morning we go to Ogepuk. The weather is sunny and windy. A starts tow. (usual Cancharge) mid 7:35 am. Then out along reef. 8:13. Sees one large Sepiet. Right above Acropora. This ind. does HV with Bottom Half Quadruple to A. I.E. it is being consciously cryptic, performing night pattern against night background. (It is also interesting that this pattern is being performed by a large.) A resumes tow. 8:35, sees another single large Sepiet, but loses it immediately. (The population is low here too.) A continues more or less around whole island.) Nothing. I go into water 9:03. Swim over

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sand and coral bottom. Nothing. Get out 9:15 a.m.

A. measures tow. Over to adjacent island (Charles says that this is also called Ogygulep. I shall call it "Second" Ogygulep. It is more or less due west of "First" Ogygulep.) A goes around most of the island. Then we find break in fringing coral, enter small protected lagoon. A finds group of sepia immediately, and I go into water 13 mds. Ranging from quite large (although not maximum) down to small medium Gralation fairly smooth 1 ft up over coral and sand in 8-10 ft water. When I see them they are all in Dark, horizontal, facing us.

Then boat (with motor running) passes overhead. All the squid turn to face it, sink down to the bottom, in various alternations of Pale and Struck patterns, in extreme HV. One ind. has ordinary DM with streaks. DM is not confluent with dark of Struck above. It is light area above fin.

Then all the inds. relax - somewhat. Go Dark and horizontal again. A photos. I get a chance to observe the Dark fairly closely. None of the inds. has any trace of WS. Little or no Y. Certainly also entirely dark below. As far as I can tell, fin color is more or less as in Ord. or only slightly darker. (There may be a trace of very fine BB. This may also occur in Ord.)

The smallest ind., nearest to A, does extreme HV to A without altering its full Dark coloration.

NOTE: These inds. in Dark are hovering over white sand. Perhaps Dark is not "meant" to be cryptic??? At least, it seems to be less often or less consciously cryptic than Struck, etc.

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10:04. All the squids turn Pale, retreat a few yds. Then back to Dark as before. All very placid and dull. No trace of courtship. Then Pale and retreat again. What is spooking them? (R says that a 3 ft. Barracuda jumped nearby.) Then Dark again. Then Pale and retreat again. I notice that at least some of the inds go through Ord with WS during transitions between Pale and Dark. This maybe inevitable (?). Then all go Dark once again. The nearest ind to me, relatively large, does E, more or less sideways to me, without changing color.

I swim around to explore. Find small TG flat nearby. This could be a (potential) nursery for young. I think the only one that we have found in the immediate area of Ogupukap. At the moment, the water is murky and there are at least 3 small Barracudas around.

A resumes tow 10:15 a.m. Out of lagoon, along west of second Ogupukap, then back along anchorage side of First Ogupukap. Nothing of interest. Stop 10:45 a.m.

In the afternoon, we do some exploring. Over to Okupui (in "front" of Ogupukap, toward algal ridge, but quite distant, perhaps nearly a mile away). A starts tow 1:00 p.m. Over a variety of habitats, including huge TG flats. These could provide nurseries for the pups of many adjacent islands, but we can't find any cephalopods at the moment. Then we swim around offshore bank. Lots of nice coral, and even a sheltered lagoon. But still nothing of interest. Stop 2:15.

Then we go to Salar. A starts tow along a whole series of islands connected by reef (this is continuation of reef from Thorpeptufo). Tow from 3:45 to 4:40. Sees a few small blobs of ink but that is all.

Running light at Salar at night.

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Small sepiot shows up briefly on outskirts, 7:03 p.m.

7:15. Single small sepiot shows up. In Ord with WS and conspicuously white tentacles. Apparently feeding actively. At one point, shows faint trace of Bar. Then drifts off.

At least this (these) young is (are) single!

7:26. Single small sepiot drifts by, several feet below surface. Apparently in Bar.

8:14. Single small sepiot (again?). Comes toward light in Ord and WS, with DM. Then does Curl. Then retreats in Ord, still DM. A says that it also does Forward and Downward V's and also begins to Bar on outskirts of lighted area.

Back again a few minutes later. In Ord + PH, with X, DM, and conspicuously white tips to tentacles. Apparently catching very small prey quite successfully. Ignoring sandunes (and the sandunes are ignoring it).

Ca. 8:50. A sec. group of 7 small *Loligo*-types. They leave. Then 2 medium "Dorps" show up. In Ord under ordinary light. Then Red-wh under flashlight. They go off.

May 11, 1978

This morning we are going to explore the inner islands near the mainland. The weather is cloudy and windy (it rained heavily just after dawn). Water is rough.

Start out as Musakipo. The local people say that there are lots of cephalopods here (octopi and 2 types of squids - almost certainly,

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Sepioteuthis and Taligos (?) A starts tow around island 8:15. At 8:30, he finds 2 medium Sepioteuthis by dark, 10-15 ft of water, over sand and rubble bottom. They do Curl in Dark. I go into water. Find only 1 of the individuals. 3 ft up. Does Curl (perhaps V-Curl) in extreme Bar. Then drifts off in Pale version of Ord. Only very slight WS. The water is murky here, almost milky, and the Pale-Ord is really cryptic, difficult to see, in the circumstances. The animal moves into shallower water over TG. Then we lose it.

I get out of water. A resumes tow around island. Finds group of 5 large Sepioteuthis, but he cannot follow them because of disturbance by Huma fulvum. So he resumes tow again. Around coral reef to inward side, then across channel to nearby island of Illigardi. Starts lie side. See group of small medium Sepioteuthis. Over TG flat. They disappear immediately. A tows some more. See many blobs of ink. Also a large Barracuda. Then he finds large group of snails. In shallow TG flat. They also take off immediately. We swim around for awhile, then we both continue tow around island.

9:12 am. Area mixed bottom, coral, etc, scattered in sand with some TG. Find 17 large and large-ish Sepioteuthis. 1-2 ft up in 10 ft water (but near edge deeper water). Looks very much like some of the places where we have seen courtship at other islands. All the inds retreat several feet. One ind. Pies during retreat. The others are in more or less Ord. 2 or 3 inds show prominent Fin Stripes briefly during retreat. Then all the inds line up facing us in a rather pale (and cryptic) version of Ord+. One ind. Pies briefly several times more. One Pie with backward rise. In this case, the Pie

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look more like anti-predator reactions than like courtship - but see also below.

Then we see a variety of rather miscellaneous patterns. Thus, for instance, she ind. does OH with DF as it approaches another. No apparent reaction. Approacher relaxes and goes back into Ord+. A few seconds later, 2 inds. meet to one another in line, turn completely Dark all over. Then relax, go back into Ord+. (NOTE: These Dark's may well have been intraspecific. If not, and 1 of the inds was reacting to us, then Dark may be "contagious".)

Then the nearest ind. to me suddenly advances toward me in Pic! I notice that this individual is the largest in the group. As it turns out (see below), she is obviously ♀. Then she relaxes and goes back into Ord+ again.

A few seconds later, she turns Pic again. This time she retreats backward in a typical "backward run". She is followed, closely, also backward by her nearest neighbor, ♂ 1. He is in Ord+. Both relax momentarily. Then ♀ does another backward run in Pic. And she is followed, again backward, by same ♂. This time, he assumes Quintuple Stroke (definite), briefly, while following.

Then the 2 animals start shooting back and forth, a few yards forward then a few yards back, again and again. (NOTE: This is obviously the same thing as "Rocking". Only in this case there was little or nothing in the way of rises and falls). Most of the time, both inds. were in Pastel with Fluttering. Perhaps a rather yellowish version of Pastel. I did not notice any B. The ♀ Pic'd occasionally. Always, I think, going backward. The ♂ usually accelerated when

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going forward, getting closer to the ♀. Perhaps also bending. Obviously by a form of jarring. Perhaps it was these approaches that caused the ♀ to go into reverse. In any case, I did not see any real studies or copulation attempts.

Then I notice that there is a 2nd ♂ associated with the pair. Following along behind and to the side. As far as I can tell, always on the side of ♂1. (I.E. ♂1 must be interposing.) ♂2 usually 1-2 ft away from ♂1. He is usually further away from ♂1 than ♂1 is from the ♀. This spatial arrangement seems to be quite typical. ♂2 is in more or less extreme Lateral Silver throughout. Silver side toward the pair. (I.E. this is unusual in several respects. The silver is toward the ♀. But presumably only because ♂1 is in between. Obviously ♂1 is the intended recipient. This is good evidence that Lateral Silver is a "purely" ♂-♂ display. It is, I think, ^{remarkable} however, that the Lateral Silver should be performed by a subordinate or accessory ♂.) The dark side of ♂2 may be either PH (with visible barring), Ord, or an intermediate. The Lateral Silver is accompanied, all or most of the time, by a slight indication of Z spread on the arms. Comment: this subordinate or accessory ♂ seems to be more aggressive than most. I see, however, that he is definitely smaller than ♂1.

Every once in a while, especially during the backward phases of the back-and-forth "rocking", ♂1 shoots backward particularly vigorously and shears off toward ♂2. Obviously attempts to warn off the latter. Once, one of the ♂s does complete Z spread (Z extending to back) when they come particularly close together. This high intensity Z is, I think, performed by ♂1.

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Fairly active courtship continues for some minutes. Now I notice that both ♂'s have rather small but very white RL continuously. What in the world does this signify?

Courtship eventually declines, no doubt temporarily. Everything is fairly placid by 9:43 a.m. ♂ 2 (still) in Yellow-PH much of the time. The ♀ still Pies occasionally, even when she is not being approached by a ♂. Once she does Pie in apparent response to an approach by A who is photographing!

Once, another (4th), smaller ind., does low intensity Pie (covering half of body, the rear half) when A approaches.

I get out of water 9:50 a.m. A continues photographing.

COMMENTS:

Obviously the population (at least of adults) is less reduced here than at the outer islands that we have visited (so far) on this trip.

The Ulzardi animals certainly are courting. Low intensity. I would suppose that they are just beginning, as the courting pair or trio is continuing to associate with other companions.

I am still worried about Pie. Obviously the pattern is usually used by ♀'s to reject "unwelcome" approaches by ♂'s. But ♀'s will also do it when not being approached by ♂'s. Is this "flirtation"? Is it used to excite ♂'s? To do what? Could it be comparable to the "wailing" of ♀ ducks ??? Is it ever used as an anti-predator pattern? (I suppose that a reproductively motivated ♀ might become so pent up, with such a lowered threshold, that she might release her "reproductive hostility" upon some non-sexual object.)

ADDITION: There were several goatfishes, of both species, feeding

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on the bottom below this counting group.

In the afternoon, we go out work near mainland shore, Rio Cienras (Lidra?), etc. A starts tow from Cont 12. Jason goes over large expanse of TG flats. 1:05 near Mangrove Islet, sees 5-6 small Sepiots. 2 of them do HV with strokes. Disappear immediately. A continues tow. Finds another single small Sepiote. It rises and disappears. A continues tow, out over TG flats to offshore banks and reefs (perhaps 1/4-1/2 from mainland).

1:45 pm. A sees 3 small Sepiots. Blob of ink nearby. The 3 animals do CVL in dark. Apparently mimicking ink. Then disappear.

Back at Mangrove Islet. A sees large mixed group. Includes 23-24 Sepiots, 7 Dorys, and 3 Lollis!!! Over TG flats. Sepiots range from small to large, medium or small. The Dorys are somewhat larger than the small Sepiots (and quite uniform among themselves). The Lollis are relatively large, approximately the same size as the largest Sepiots. The Lollis tend to be the lowest in the group, nearest the largest Sepiots. The Lollis are also more or less colorless, showing little or nothing in the way of color changes. (*Lolliguncula* does seem to have fewer color patterns and changes than many other cephalopods. Why? Because these animals often live in murky water???)

The whole group moves off some distance. I get in the water and swim in their direction. Following a trail of ink blobs. Ink is black. When I catch up with group, the Lollis have separated and gone. A doesn't know where. I.E. the Lollis may associate with other species on occasion, but their interspecific bonds are not strong. But all the Sepiots and Dorys are still together. And obviously beautifully integrated.

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with one another. The animals are 1-3 ft up in 5-6 ft. water over TG edge of small coral reef. Dorys are all HD in Ord. Several have CL. One has relatively large dark patch in approximately same position ventrad. (This could be ink sack, but it is much larger than the usual ink sacks of the other species.) The Ord of the Dorys is rather pale. They all, however, have dark bar across top of head (eyebrow ridge). This is either masking & from our point of view, or it may be really absent. The Sepiots are in Ord + (conspicuous WS and PCA) more or less horizontal and/or with slight HD (much less extreme than that of the Dorys) or slight downward pointing of the arms. All the animals of both species are facing us.

There are several minor games. All animals retracting a few ft. All retreats backward. All animals with head and arms more or less horizontal during retreat. Dorys do not change color during retreat. Only possibly become even a little paler than before. All the Sepiots, however, go into streaks. In at least one case, the streaks are only Quadruple. (Perhaps Belly stripe only occurs when it can be shown off - i.e. in such patterns as HV and Upward Curl?) This is a good example of a point mentioned earlier. The streaks must be startling rather than cryptic when they are horizontal against a background of vertical TG.

The Dorys are a definite subgroup within the larger group. For a while they are "huddled" all together with Sepiots on all sides of them. Then they tend to occur to one side or, more frequently, above all or most of the Sepiots. (This does not, however, necessarily mean that a Dory on the "edge" is closer to its nearest neighbor of the same species than to its nearest neighbor Sepiot.)

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2:05 pm. The whole group moves into deeper water. Both species moving smoothly together. They stay close to the bottom. Then they all drift upward and up. Still together. Then they drift further away from us. Backward. No color change. Some Sepiots definitely in "lead". (I think that this also is typical. Sepiots are more often leaders than are Dorys in mixed groups.) The animals drift out over the TG flat. 2:15 the group seems to be smaller now. Includes only 3 Dorys and 13-14 Sepiots. Still calm and integrated.

A saw one Dory feed or attempt to feed. Dashed forward and then immediately back to its previous position. Like a mechanical toy. I did not see any feeding by individuals of either species. Again I think this is typical. The daytime associations of the two species are essentially resting groups. They may not really associate socially, except in the daytime. Although individuals and groups of the 2 species may occur and even hunt in the same areas, in close physical and temporal proximity, at night, they probably are not really integrated at such times.

We stop observations of mixed groups 2:25 pm. A tow along long stretch of mainland mangrove shoreline. Nothing of interest. So we go back to boat 2:50 pm.

SAN

A goes back to Ilgardi later in afternoon.

SAN

Running light over mangrove inlet at night. Lots of wind. Water very rough. A few sandbars and crabs.

7:55 pm. A single small squid shows up briefly. Either a Sepiot or a Lilli. Rather far down. Apparently colorless.

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This same individual comes back a few minutes later. Then goes off again.

Nothing more. We stop 8:50 pm.

May 12, 1978

Start at Algarde this morning. At site where A provided shells for a nest for a presumed ♀ that looked as if she might be in an egg-laying mood. (Note: this area certainly looks unsuitable for egg-laying. It is essentially pure TG flat.) A inspects "nest" 8:10 am. No sign of either "♀" or of eggs. So A starts tow around island.

Only a few minutes later, and a few yds further on, finds group of 52 small Sepiots. All close together, midway in 2 ft. of water over TG. None is very small, some are almost reaching medium size. Mostly in Ord +. The individual nearest me does HV (not very extreme) with Bottom Quiet. Belly toward me, definite "display". Relaxes. Then goes Yellow with Fin Stripe facing away from me. Showing back? (What is the significance of Fin Stripe ???) Then a more elaborate performance, quite reminiscent of one seen a few days ago. Alternates brief periods of HV with Bottom Quiet with periods of more or less horizontal or even slightly tail up postures, showing typical (2 spot) DM on rather Yellow with Ord + back. This ind. stays close to me during this performance while the other members of the group drift several ft. away. I.E. it is effectively a display.

A photographs.

Then, only a few ft or yds away, we find 2 large Sepiots. One

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and Ord + on back

is the ♀ that A saw yesterday ("she" has characteristic scar on back)
Really very large. I shall call "her" I. The other ind is slightly smaller.
I shall call it II. I does E to me. With body tilted in usual
E fashion and extreme Bar (3 bars) on the Belly. I shall call this
"Bottom Bar" Very conspicuous, obviously "display". Then retreats in
Pole, with definite DF. Then does E again with Bottom Bar. DF
continues in E. Could DF be the lowest intensity component of the "V
complex" ??? While this is going on, I see that II, 3 ft away, is doing
extreme HV with Bottom Bar to A. Note that these inds. are almost
certainly adult. And the Bar and Stroke seem to be virtually equivalent!

A photos while I write notes

As far as I can tell, these inds. are not counting.

When I resume observations, I see that I is in perfect Yellow
(really a golden tan), without a trace of the dark marking of typical PH,
near A. With Y. Without WS (although there is a white scar on middle
of back). Little or no PCA. Pelli on back are conspicuous. There is one
row of large (enlarged?) ocelli down each fin. Belly is clear yellowish
most of the time. There is no B. Posture is horizontal.

Every once in a while I shows trace of Bottom Bar below. This
occurs when A approaches. Then I does several E's to A. Still pure
Yellow above. Sometimes Yellow, sometimes Barred, below. Once
with (2 spot) DM below fin. Belly usually directed facing A, or to
one side. In any case, belly pattern is always visible to "pet predator".

Then we get the 2 large inds. between us. I still in Yellow.
Does C to me, with Bottom Bar. Then just floats horizontally,
still Yellow, with DF. Then does a little "rocking". Once does E.

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Barring remains throughout. Sometimes stronger, sometimes weaker. When it is weak, the Bars tend to break up into "fragments". The general effect is reminiscent of (identical with ???) Speckled Belly. Once I shows ordinary DM on back. During this period, II, 1-2 ft away, also does a little "rocking". Always in horizontal posture. Always in Ord + above. Both WS and PCA prominent. I don't notice Y. Traces of Bar alternating with not very strong Dark below.

This "pavi" absolutely refuses to move. I approaches within a few inches of my leg. At one point, I thought that she was going to touch me. Are these animals really territorial? I think so.

The group of smalls is still around. About 5 ft from Larges. Apparently slightly segregated at the moment. But see also below.

The Larges continue behaving more or less as before. II does several E's, back toward us, Ord + above. I think (still) Dark below.

8:44. II has fallen some distance (3 ft.?) behind I now. It is approached, quite closely (2-3") by the largest of the smalls. There is no visible reaction between the 2 inds. Both in Ord +. Then II does several more E's, back to me. Still Ord +. But one momentary "flash" of Bar on back superimposed on Ord +.

I is now some distance from me. But still in Yellow with traces of Bottom Bar. Why? Is she just more aggressive or fearless than the others? If so, again why? Is it just that she is the largest of the group?

None of the squids seems to pay the slightest attention to any of the numerous (grazing?) fish in the immediate vicinity.

We stop observations of this group 8:47 a.m. A resumes tow around island. 9:00 a.m. Area where courtship seen yesterday. Group

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is still around. Now includes 6 inds (larges). When A first sees them, courtship seems to be active. He sees several Pres and Z-Spread encounters. By the time I arrive, courtship has stopped. The animals seem to be reacting to us, although not very vigorously. One ind. does E in Dark. Then whole group retreats in Pale. Several inds. have Fin Stripe in Pale. Is Fin Stripe rather high intensity alarm? Then the animals relax. Resume Ord + etc. Several more E's in both Ord + and Dark. One ind does HV with Bar superimposed upon on Ord + above (I can't see below). Then more HV and E performances in Dark. Then one Curl in Dark. Note: all these performances are more or less directly over Acropora. They cannot be all equally cryptic in the circumstances!

A has been photographing while I have been making these observations. Now he moves away. The animals seem less disturbed. But courtship does not resume immediately (although spawning arrangements would suggest that the "trio" still exists). It is obvious, I think, that these animals are just beginning reproductive activity.

I get out of water 7:15 a.m. A resumes tow around island. Finds another group of 8 medium-larges over reef. They don't seem to be doing anything very much so we go on. Then A finds another single large in shallow water over coral. Again not very active.

COMMENT: At least the pop of tepees here is much larger and denser at the moment than were the pops of the outer islands that we visited on previous days.

We leave Ilgandi and go over to mangrove islet by mainland. A tows 7:36. Nothing! We give up 7:50.

Ceph., May 12, 1978, V.

(30)
525

Very mangrove wet again 11:33. A tow. Finds 30 small to me
down sepiots almost immediately. 2 ft up in 5 ft of water over TG. Larger
vids. at both corals. Mostly in Ord+. Not very active. So we swim
around. Find 4 medium-large sepiots 3 ft up, over Acropora, in 15 ft
water. Also in Ord+. One does Curl. One does extreme HW with Bottom
Quad below, Ord+ above. Definitely directed to us. I get out of water 12:20.
A continues tow-around island. Stops 12:40.

The Dory and Tolly certainly are not continuous residents here!

Then we go on to Tulucitupor — one of the "middle" line of islands.
A starts tow 1:35 pm., around island and extensive offshore reefs. 2:05.
Finds 6 large sepiots 2-3 ft up in 8 ft water over white sand near
coral. Joz in. The vids are in Ord+. Retreat to deeper water. 2 of
the vids go off. (A watches them, see Lateral Silvers and, probably,
Pies). The 4 vids. in front of me remain low and go Dark. Then
retreat again. Go Ord+ (from Dark) during this second retreat.
Is this further evidence that Ord+ is intermediate between Dark and
Pale ??? Then the vids. relax. Go Dark again. Seem to be divided into
2 two pairs. One vid. does Lateral Silver, facing in opposite direction
from its "mate." / 7 Silver on far side, away from "mate," as usual.
Partner does not respond. Displaying vid., presumably ♂, goes
Dark again. Then does Lateral Silver again. This time 7A. But orient-
ation of silver side is conventional. Partner remains Dark throughout.
A photographs.

All this seems very preliminary!

I get out of water 2:25 pm. A resumes tow. A few minutes
later, he sees 8 young 10 ft down in 15 ft. of water over coral. 2:47,

Cepl., May 12, 1948, VI.

(31)

526

still proceeding along reef, he finds 2 langes, 10 ft apart. Apparently not interacting. So we continue. 3:04 see large ink blobs in deep water, but can't find animals. Stop observations 3:05 p.m.

Go on to Icutupo, another middle island. A starts tow around island and reef 4:02. Nothing of interest.

Running light at night at Ulaosucun (nr. San Blas Point)

7:10 p.m. Single small Dory type shows up. In sort of Pale Ord. Circles happily in swarms of sardines.

NOTE: L. (D) plac, or at least young individuals of the species, are not "offshore" types. Perhaps as littoral as Sepioteuthis ??? But, if so, where do the adults hang out in the daytime?

Small Dory type disappears after about 5 mins.

8:46. Three larger Dory types show up. Red-dish. Then go away again.

May 13, 1948

Young exploring again. Start out at Cuka. A begins tow around Icutupo 10:00 a.m. Goes all around island. Then over to Reipita. Out along reef. We go into water 10:53. O sees single small Sepioteuthis on TG flat. It disappears immediately. Get out of water 11:06. A tows over to Tupile and around island. 11:16 A sees single large Sepioteuthis. It goes off into deeper water immediately. We continue. Finally stop 11:45 a.m.

Obviously squid are not common in this area now!

Go on to Soledad in the afternoon. A starts tow around island 2:00 p.m. Then out along reef. 2:22 finds group of approximately 32.

Cephalopods, May 13, 1978, III.

(32)

527

medium (and) to large squids. In shallow water, between coral
around 16. They move off into or over deeper water. I cannot see the
group very well. But 2 inds., not together, certainly see, with back-
ward rise, essentially simultaneously. So there are at least 2 counting
pairs (or trios). But then whole group disappears from our view.

We go on a little farther, ca. 2:30, and we find a much larger group
of squids. Really very large indeed. Low in 10 ft of water over 16. Group
includes over 150 inds! All sizes from really quite small to large.
Difficult to see, as water is slightly murky and the light is poor. As far
as I can tell, all or most of the inds. are in Ord., horizontal or with
only slight traces of HD or downward pointing of the arms. A sub-
group of little squids near me is quite close. But the others seem to be
skittish. Disappear. (The animals around here are shy in general,
with exceptions. Why? Too much boat traffic? A lot of wave action?)
I get out of water 2:45 pm.

NOTE: there were a lot of grazers near this very large group of
squids. The ones that I see probably are juvenile parrotfishes. Of
either or both parrotfishes: the Princess Parrotfish, Scarus taeniopt-
erus, and/or the Mottled Parrotfish S. croicensis. I did not see any
goatfishes at this place and time. A says that he saw both species of
goatfishes, at least briefly, in the general area. He also saw the parrot-
fishes apparently following the squids when the goatfishes were not
present!!!! (Additional note: A also says that these young parrot-
fishes are difficult to distinguish from squids at a distance. There
are in similar groups or similar ways. SAN. Minding?? I doubt it.)
3:00 pm. A comes out and around offshore bank. Sees a few

Ceph., May 13, 1978, IV

(38)
528

small ink blobs. Nothing else of interest. Stop 3:25 p.m.

We anchor boat off Malumega in late afternoon 6:00 p.m. 8 small Sepiots show up near boat. Sand and mixed bottom. All in Ord +

Run light at night. Hundreds of small sandunes but no squids.
Stop 8:10 p.m.

May 14, 1978

Going to work around San Blas Point this morning. Start 8:55 a.m. Cover wide area and great variety of habitats. A teens. We also swim around quite a lot. Over area where I saw squids a couple of weeks ago. Then out to area (inside algal reef) where octopi are supposed to be abundant. A sees one small octopus briefly. Nothing else. No squid. We stop work 11:00 a.m.

Back to ship. Ca. 11:30, a Kuma swimming in water near ship finds large group of Sepiots, all sizes, perhaps 200 inds!

Perhaps the squids are not so much scarce as clumped now? If so, why?

NOTE: It is possible that most of the large Sepiots bred a few weeks or a month ago. Perhaps the distributions and numbers that we are finding now could be explained on the hypothesis that the old adults have died while the new, coming, generation is still in the egg and/or larval stages???

A and O photograph Malumega squids in afternoon.

Later in the afternoon, we go around Pico Teo. Ca. 4:00-4:30 p.m. A sees some ink blobs, but that is all.

Ceph, May 15, 1978, II.

(34)
529

Run lights at Malunega at sunset. Lots of sardines.
Also 1 group of small sepiots and 1 group of small Dorys. No. of
inds. in Dory group 8-12. Sepiot group of same order of magnitude.
Both quite low, difficult to see. Both groups present at same time,
but apparently not integrated with one another. As far as I can tell,
all or most inds. of both species in Ord (+).

Later a single medium Sepiot appears at surface in Bar.
Feeding on small prey.

May 15, 1978.

Going to try inner islands this morning

A tours around Soledad Mandinga, Muluatupo (Munatupo?)
and Arutupo 8:45-9:35. We also do some swimming. TG flats and
mice coral reefs. But nothing of interest.

When we get back to ship, anchored off Soledad Mandinga,
we find that 7 small sepiots have been hanging around anchor rope.
Apparently in Ord +. Rather low. Drift off shortly after we arrive.

NOTE: Soledad Mandinga is not the same island visited a
few days ago. That was Media Soledad.

As it happens, this afternoon we go on to vicinity of main
land near Media Soledad. There is a mangrove inlet there,
rather like the inlet near Musatupo but larger and more dis-
persed.

A starts tow around inlet 4:40 pm. Essentially a shallow
TG flat. 4:50 he sees group of sepiots. They ink and bolt before

Ceph. May 15, 1978, II

(35)
530

we can do anything with them. A few minutes later, A sees (another) large group of small sepiots. They (also) take off immediately. Then we cross over to mainland. Toward explore along mangrove shore until 5:35 p.m. Nothing more of interest.

Running light at night at same (Media Solida) mangrove wet.

7:12 Group of 4 small (or small-medium) Dorys shows up. All ends in End. Go away almost immediately.

8:18. A sees 2 "large" Dorys fairly deep. Disappear.

May 16, 1978

Quite a lot of heavy rain early this morning. It has been generally overcast for 3 days now. So the water has become colder than before.

We start out at the (Media Solida) mangrove wet. A begins tow 8:50 a.m. All around wet. Nothing. We explore shallow banks inside mangrove. Muddy. Still nothing. Stop 9:20.

Over to Media Solida itself. A starts tow 9:30. Ten minutes later, sees single large sepiot, in sand (deep) water, some considerable distance away from coral reef. In Barn with "contorted" arms. Just what would be expected. Disappears immediately. Stop tow 10:00 a.m.

We go on to Muratupo. A starts tow 10:57. Goes around island. Then, 11:10, finds group of 5 very small sepiots. One of them looks. When I get in water, there are 3 near me. One is almost larval. Half way up in 20 ft of water over sand and TG. At least 1-2 ft apart from one another. I.E. still too young to be very tightly gregarious.

Ceph., May 16, 1942, II.

(36)

531

They perform both E's and Curls (very extreme). In Dark and in Dark-Bar (Note: this is what A. calls "playing curl." It is also, of course, mimicking Libus or Sargassum).



The animals disappear while I am writing notes. We cannot find them again as water is quite murky.

Then we go on to Ilgardi. A tour all around island, past areas where I-II, group of smalls, and courting groups seen a few days ago. Apparently molting. Stop 12:05 pm.

COMMENT: The animals are certainly mobile now. Not sticking to particular areas. Perhaps more mobile now than when populations are higher?

2:05 pm. A starts tour around local mangrove island (where 3-species school seen a few days ago). Nothing new. Then over to shore, to two further mangrove islets, then to offshore bank, then around Ilgardi once more. Still molting stop 3:30 pm.

NOTE: There are quite a lot of birds around here now. Many Black Terns. A fair number of Little Egrets and Brown Pelicans. The occasional Great (Ringed) Kingfisher (always single now as far as I can tell).

We go on to Morpeptap in late afternoon.

Penlight at night.

6:30 pm. Only a very few small sandeels. Then a single small sepiot shows up. Then surface. Feeds on invisible prey. In Ord+. But with tips of tentacles (and arms) conspicuously white. I shall call this "WT." I am sure that we saw this in other small

Ceph., May 16, 1948, III

(37)
532

Sepiots feeding at light a few nights ago, but I did not note it down. Presumably WT could (like DF?) function as a lure?

2 more small Sepiots show up a few minutes later. Apparently behaving in same way, SAN.

6:58. 2 small Dorys low down. Probably in Ord.

7:07 3 small Sepiots show up (again?) Coming from different directions, I.E. They are not swimming as a close group. All in Ord +. Go away.

A few minutes later 3 or more small Dorys appear (again?) Then more and more small Dorys show up. Must be at least 20. Rather scattered. A few inches to a ft. apart. Facing in all directions. Not a coherent circling school. All in Ord. Some with a trace of "CL" - like pattern (perhaps only trace of bar of iridophores showing through at certain angles??). Dorys go off.

The Sepiots and Dorys certainly are not associating with one another now.

Probably many of the animals just go lower in the water column when they disappear from our view. But we certainly cannot follow them there.

7:31. A catches small Sepiote. Probably just past larval stage. We put it in bucket. In Bar with Upward V. Bar is quite stereotyped. Front bar (front part of body) faint, or even absent at times. The other 2 bars quite strong. 3rd bar (near) prolonged by DAI (on fin?). The animal swims around energetically. Turns several times without changing color (or V). But then V tends to become more Forward than Upward. Then we suddenly turn

Ceph, May 10, 1978, IV

(38)

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flashlight on. Animal immediately goes extreme Dark (with Flare and V or Upward Curl). Playing Ink. (Note: one might have expected Bar in these cases. But since the animal was in Bar already, it "had" to do something else in order to be confusing or startling.) Then, the animal, rather gradually, gets paler, passing through Bar phase, ending up in extreme Pale with typical (2 spot) DM. (NOTE: Ord + is not inevitable during transition from Dark to Pale. Is it inevitable during reverse changes ??? I doubt it.)

8:15. A very small Sepioid appears. Coming up under light. Very pale in color, with V. Then goes Ord + in shadow of boat. Disappears from view. Then reappears at side of boat. Drifts over 3 small Dorys (deep). No apparent reaction by anyone.

NOTE: A says that inds. of Loligo peruviana will dispute over food (in captivity). Also one will take food dropped by another. Presumably unlike Sepioteuthis. (But like Dory ???)

There is no doubt but that large Sepioids are relatively very rare in this western portion of the San Blas now.

May 14, 1978

Spend the night at Morpetugo

6:15 a.m. A sees small Sepioid near ship. In Ord +. Does V pattern. Fifteen minutes later, he sees 2 more small Sepioids near ship. Too low to observe details.

Are young just beginning to drift in from open water to nurseries?

Ceph. May 17, 1978, II.

(39)

334

Is this change in life cycle? Or just the "usual" everyday morning concentration?

6:40 a.m. Lucha sees surf small Sepioteuthis, rather low, lay anchors rope. Apparently moves on.

NOTE. Water is very smooth here today. This may permit or encourage the animals, especially small ones, to rise toward the surface.

7:15 a.m. Just as we are getting ready to set out, we notice group of 14 small Sepioteuthis under (small) boat. They near surface, only 20-30 ft of water. A is already in water, but I don't dare go in for fear of frightening the animals. According to A, they are doing V's when he first appeared. They relax almost immediately. Horizontal in Ord + (including?) Some of the inds are quite small indeed, just past the larval stage. A photos and approaches them. They retreat and circle around boat. In Ord + throughout. One ind does forward V in Ord +. A continues photo-ing. The squid circle around boat again. This is obviously purposeful. Keeping near "shelter"? Then they all cluster around rope of boat (looped in water) and they all go Dark as soon as they do so. There is one tiny mottled fish also sticking to rope. I think it was there before the squids arrived. In any case, the squids seem to ignore it and vice versa. A continues to advance slowly. The squids retreat slowly, abandoning rope. Still in Dark, at first, as they retreat. The mottled fish does not abandon rope, i.e. it does not follow the squids.

Then the squids cluster under the boat. Back in Ord +. Carlos puts ear in water. According to A, all the squids Ink, without color change, and shoot away. Come back almost immediately. Then do H in Pale or Pale-Ord when Carlos moves on again. Retreat. Back again. I go into water. All inds. in Pale version of Ord + (ink sack visible and conspicu

Ceph., May 19, 1978, III.

(40)

535

ous). Body horizontal. One ind. may show very brief and slight trace of Bar superimposed upon Ord + several inds do ID, without color change, when I move an arm. Then they suddenly disappear, unobserved, while I am writing notes.

COMMENT: I think that Dark may be particularly likely to be performed by animals "taking shelter" under, in, or near fairly large objects (including coral).

A starts tow around Morpupupo 7:32 a.m. Then over toward Taptupo. 8:36 He sees 2 small Sepiots in shallow TG flat. They ink and take off. Then Carlos finds octopus. It retreats into large conch shell. We collect it and take it back to ship 8:55 a.m.

We put the octopus into chest. It gradually comes out. Dark all over. A says that this indicates that the animal is disturbed. Throws arm & chest several times. Still in Dark. Then gets lighter. Settles, curled up, in corner. In pale mottled pattern, with puffed skin. This may be the "Ord" of the species (and/or "general mottle", "acute general mottle", or "conflict mottle" of Packard and Hoelbling).

NOTE: Some Darks of some ceph. and perhaps some other cephalopods, seem to be higher intensity reflections of greater disturbance, than all or most Darks of Sepioteuthis.

While we are installing the octopus in its new home, Luchio tells me that there have been 2 small Sepiots at ship and/or rope. Also group (12 inds?) behind ship. Feeding on, or at least showing an interest in, very small sardines. This group may well be partly the same as the group of 11 seen earlier this morning.

9:20 a.m. Single small Sepioteuthis shows up near side of ship. In Ord +

Ceph, May 17, 1978, II

(41)

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Tentacles partly extended straight for ward (in direction group of sandeels). Definite WT. (Is this really ritualized? Can clubs of tentacles ever be anything but white? I think so. How about various V, Dark, and Pk's patterns??? Can WT occur even when tentacles are not extended? Again, I think Yes.) Then points arms downward, while head and body remain horizontal. Then suddenly dashes back and away.

9:26 A says that there is a group of approximately 6 small Sepiots under small boat.

9:45 a.m. We get ready to go out again. A single small Sepiot comes in toward small boat (again). At first in Ord +. Then turns Dark as it gets close to hanging rope. Three other small Sepiots also appear and approach rope. Also Dark. All horizontal. Never close to rope. But no particular tendency to keep tail toward rope and to face outward. They follow the boat and rope when Carlos pulls it forward!

It is interesting that these smalls near surface have shown no trace of Strakes or Stripes. Even more remarkably, there has been only one Cuv's and slight trace of Barring. Why?

9:53 A starts tow out from slip along offshore bank. 10:01 sees 3 small ink blobs. Can't find animals. Continues tow. A few minutes later finds 4 ink blobs and a large Barracuda. Then more blobs. I go in. 12 ft of water over TG. We swim around. Move and more ink blobs. I get out of water. A resumes tow 10:15 a.m.

A few minutes later, he finds group of 3 medium and 2 large Sepiots. Low over TG-mixed bottom. Do Bar in slight HV. With extreme and rather peculiar "Contorted" V. Some arms upward, other arms downward, sort of spread out or flared SAN. Then they assume Strakes with

Ceph. May 17, 1972, V.

(42)

537

more extreme HV. Then they leave.

I go into water. We swim around. Find group of approximately 14 small sepia. They take off in streaks (probably *Quadruplex*?). We swim around some more. Find more ink. One blob is quite reddish.

I get out and A continues to swim. More small ink blobs. Quite a lot of them in fact. COMMENT: the population of small squids here must be very large. Is it getting larger rapidly?? (By our observations here a few days ago).

I go back in water 10:55. We swim around. Get brief glimpse of 11 small sepia near large ink blob. The animals take off instantaneously. We stop work 11:15 a.m.

COMMENT: Why were there so many ink blobs this morning? Are young animals more likely to ink than are older ones??

Go out to end of Landes Cays in afternoon

A begins tow from Tialupo to Panetupo 1:30 p.m. Finds group of at least 12 small sepia in shallow TG flat. 1 ft up in 2 1/2 ft water. Note: water is remarkably warm at this spot now. Retreated in Ord +, horizontal, some do Downward Pointing (DP) with extreme CP. All inks have extreme X. One ink does extreme HV (almost curl) with Ord + (belly pale - i.e. not displaying anything in particular). Then all the inks disappear. No ink. Why no ink? Because these inks are less exposed - with so much TG so near - than the inks of the offshore bank near Mesopotamo? I get out of water and A resumes tow.

2:11 A finds 5+ small sepia. Streaks and TV in shallows over TG. Again they take off. Again without ink.

Ceph., May 17, 1978, VI

(43)

538

A shoots a Caranx ruber. (When stomach is opened later, it is found to contain a smallish fish. No squids. But the fish is as large as some medium Sepiots.)

Female Paruto 3.03. Go over to Paruto. A town. 3:27
Far end of island. Find group of approximately 30 Sepiots. Ranging from medium to large. Halfway up in 15 ft of water over sand and coral. Group includes a counting pair or semi-trio. The counting animals are large but smaller than the maximum possible. See several Pies with Backward Rises. Apparently always by same ind., presumably ♀ (and the largest in the group). ♀ does another Pie with Backward Rise. ♂₁ (who seems definitely attached) follows her, also backward, in Double. ♂₂ (who seems rather half-hearted) tags along some distant behind, in rather Yellowish Ord+ or semi-PH. Then, when I am writing my notes, A sees a rather vigorous pair, apparent cop. attempt, almost certainly unsuccessful. Most of the other inds. in group are in typical Ord+. However, suddenly they all go Pale and retreat a few feet. No ink. Then they all relax again.

♀ does another Pie with Backward Rise, in obvious response to approach by ♂₁ in Double Stroke. A photos. Then a Pie with Backward Rise by ♀ not being approached (♂₁ is just swimming quietly in Ord+, a foot or so away.) NOTE: again Pie can appear to be an "invitation" rather than a repulse. Then the ♀ swims forward in Ord+. ♂₁ follows closely in Ord+. ♂₂ seems to have lost interest. The whole performance seems to be rather low intensity.

The ♀ and ♂₁ swim back and forth together. Semi-Rocking.

Ceph., May 17, 1978, VII

44

539

I notice that ♂ has constant RL. (Is this a "permanent" signal of a sexually mature ♂ ???) Then the ♀ does Lateral Silver. Definite Silver side is toward ♂. Either directed toward him or to some third ind. behind him. Then ♀ goes back into Ord+. Then she Pies again. ♂ remains in Ord+ throughout. As far as I can tell, he doesn't respond to either the Lateral Silver or the last Pie.

Then all the animals disappear. There are more Carranx ruber in the neighborhood.

I get out of water 3:45 pm. A minute later, A says that group is back. Now under boat! Behaving as before. So we go on and A resumes tow.

4:07. Reef along point. Find group of 8 large medium Sepiots. Half way up in 8 ft of water. In Ord+, horizontal. Looking rather purplish in dull evening light. Doing nothing at all of interest. Stop work 4:20 pm.

Running light at night. Ship is anchored rather far out, approximately half way between Panetupo and Tialupo. 60 ft of water. Lots of fish show up. Including some quite large "sardines". They must be intimidating to small squids.

Miscellaneous debris floating by.

7:31. Single Sepiot shows up at surface. Hanging from surface of water at an angle like a piece of debris. In Bar (really only 2 bars above - difficult to tell if any particular "numbered" bar was absent - perhaps the two were fairly centered)



Ceph., May 17, 1978, VIII

(45)

540

Some of the (smaller) arms slightly splayed. Suddenly dashes forward and catches small sandie. No color change. And apparently the tentacles were not used. Then animal swims away with prey. Still no color change. NOTE: this animal was either large medium or small large.

A distinctive hunting technique!

A sees (presumably) same ind. come back a few minutes later. Still hunting. Makes several attacks. Does Upward Pointing or Downward Pointing after misses. Without color change. Finally gets prey (sandie), probably using tentacles this time. SAN.

17:46. Sepnot back again. Still at surface. But now in golden Ord+. Ocelli conspicuous under light. Catches small sandie. Not using tentacles. Announces Bar as soon as fish is caught. Drifts away with fish in arms. I.E. not swallowing immediately.

Back a few minutes later. Still in Bar. Catches another sandie. Protrudes tentacles slightly before capture. Tips conspicuous WT. Then catches fish apparently without using tentacles. Drifts off in Bar.

Drifts back toward light. Apparently chewing last prey. In Bar with conspicuous conventional DM.

A says that there are also 6 medium Dory types lower down in water column.

Sepnot in again. Catches yet another sandie. Now in 3-bar Bar. Front bar is partial. Top of head also dark. I.E. essentially 4-bar pattern. (I think that this may be "typical".)

NOTE: Like many other higher order predators, Sepnots seem to be able to stuff themselves almost ad lib.

Cephalopods, May 17, 1976, IX

46
541

Sepnot in again. Bar with "splayed" E as it approaches. Then flashes arms. Then catches still another sardine.

8:00 pm. This Sepnot probably has eaten at least 12 sardines since it first arrived. A says that twice it caught 2 sardines (2 strokes - but the second before eating first prey).

Sepnot finally drifts off with a large mass of debris. Then back again. In Bar with Upward Curl. Twice goes into Ord, still with Curl, when A shines flashlight on it. Returning to Bar each time when flashlight is turned off.

COMMENTS: (1) This animal is being very consciously cryptic indeed. (2) Bar might be usual pattern of all animals at night. (3) It is difficult to believe that this Bar is really an indication of alarm. (4) The mimicry of Sepnotentris is obviously much more complicated than the matching of background tone and text were by Octopus (Packard and Hochberg again).

9:23. A says that Sepnot has been back again, grabbed 2 sardines, and left once again.

In again 2 minutes later. In Bar. Does Curl. Lower curl. Strokes. Gets very small sardine. Drifts away. Always in Bar.

Presumably these Bars, Curls, and E's are designed solely to mislead prey? The opposite of "luring"?

Sepnot in again. This time comes in backward in Bar. A ref. comment of mimicry or cryptic? Suddenly whips around, shoots forward, catches another small prey.

I suppose that it must have caught 30-40 prey by now.

8:40 pm. More and more debris drifting by. Including

Ceph., May 17, 1978, IX

(47)
542

detergent suds!

Stopping 8:45 pm.

May 18, 1978

Puialupo again this morning. A starts tow coral side point 7:58 am. Nothing. Then along coral side island. Goes over area where courting seen yesterday. Apparently nothing now. Then back over same route again. Still nothing. I.E. the animals seen yesterday have definitely moved.

Then over to Quiriquintupo 8:55. We tow and swim around island. Nothing of interest. Stop 9:30 am.

Go onto Ogupukup. A starts tow along usual route around first island and reef 10:10. Nothing for a long time. 11:04 I go into water, far end island, strait between first and second islands. Find 33 Sepiots. All large or large-mediums (I think). Halfway up in 15 ft water over mixed sand and coral bottom. At least one courting pair. ♀ Pus with only slight Backward Rise. ♂ immediately does Double, obviously in response, swimming not far from ♀. But he makes no attempt to approach her. Both inds. relax. Then there is a brief and mild panic. 12 inds retreat, backward, past me. In semi-Pale Ord+. One ind. also has Fin Stripe during retreat. Comment: Fin Stripe is not really an integral component of Streak complex. More of an intra-specific signal? Then animals disappear. I get out of water 11:20.

A starts to tow around second island. 11:36. He finds group of 3 large Sepiots. Obviously high intensity courtship. 2 ♂'s do prolonged

Cypr, May 18, 1978, II

543

Z with spread white of floats some ft away. Then the animals disappear immediately.

NOTE: The current here is very strong. As was the current in the area by Pinnatops where courting was seen yesterday afternoon. This does not seem to bother adult leopards.

A complete tour around second Ogunakips without seeing anything more of interest. We stop 12:20 pm.

Go back to strand between the two Ogunakips. A begins tour 2:10 pm. Around and first island. Then over to second. Pass over area where courting seen this morning. Nothing there now. Back toward first island. I go in water. Swim around for some time.

2:45 pm. Mid-channel. See group of 50+ leopards. Halfway up in 15 ft of water over sand mixed bottom. Group includes everything from large to very small (tiny). The inds are in Ord+ (conspicuous WS, PA, and Y), in more or less horizontal posture. Large inds. at one end of rather irregular line. The very largest of all is at the very end. This ind. seems to be ♀. She Pies briefly. No apparent response, not even nearest neighbor (presumably ♂). Then I see 2 blobs of ink in water. I don't know who produced them - or when. Suddenly all the inds. retreat in semi-Pale. (This looks like Part II in the ambient light).

All the inds. back a few seconds later. Still in Ord+, horizontal. Very inactive. Certainly not feeding.

Then one ind. Pies briefly in center of group. Probably not the same ♀ that Piced earlier.

Then things become a little more active. Several Pies by one ♀. One of these Pies is a response to, or perhaps provokes, a Pan by adjacent ♂.

Ceph., May 18, 1978, III.

(49)

544

♀ is swimming forward (now in Ord + ?) after Pie. ♂ swims forward along side her. Accelerates in Ord + - Double Stroke. With conspicuous Flutter and Bends. But apparently no real cop. attempt.

Then there are more Pies by at least 2 inds. Annotated with some not-very-vigorous Panes. Panning ♂ is in more or less Ord +.

Then everything quiet again 2:58. The group as a whole, including the trios, is sticking together quite cohesively. The courting inds. are not showing any tendency to "string" away. Obviously courtship is low intensity. But note that ♂'s seem to be able and willing to make vigorous Panes from the very beginning.

There is at least one Spotted Goshawk feeding below the squids.

A is photographing. Suddenly one ind. in middle of group does full Pie with extreme Downward Pointing when he approaches closely. This would clearly appear to be a response to the approach. ♀ & ♂ reproduce well motivated ♀'s - even if they are not yet ready to copulate - can still Pie to any sort of irritating stimulus (not only inopportune ♂'s of their own species).

I come out of water 3:05 p.m. A stops photographing 3:10.

Then we go on to western end of Holanda's Cay. A tows around Esmeraldo. Nothing of interest. Then starts to tow along lee shore of Minatupo (Maratupo?). Water very murky. We stop 4:25 p.m.

Finally to the very tip of western Holanda's. Anchor ship off (Western) Tatupo and Manuui (Moo Kay?). Going to run light at night.

A few sardines show up early as usual.

8:05 A large squid suddenly comes up from the depths.

Ceph. May 18, 1948, IV

545

Looks very pale and golden. Catches 4-5 sardines in a row. Certainly not pausing to feed between catches. Then drifts away.

Back a minute later. Now in Bar with Curl and Upward V-Curl. Catches more sardines.

Sepiotentris does tend to be a solitary hunter at night!

Same ind. comes in again 8:14. Bars against a golden background. Arms flared and curled. Only one tentacle. Repeated darts and grasps at prey. Apparently unsuccessful! Drifts away. Back again. In Bar with upward V-Curl. Then catches sardine with arms. (Remaining tentacle seems to be rather ineffective.)

Back again in Bar with E, then with Upward Curl. Frightened off by jumping Half-beak.



In again. Bar. Arms flared. Catches another sardine with arms.

NOTE: Bar is usually 3-bar (on body). But "front" bar is incomplete.

This ind. comes back again and again. Once captures sardine in complete Ord+. Then reverts to Bar.

It seems to be almost unsatiable. Like ind. seen last night. Tip of single tentacle certainly is white and conspicuous. Garfish pines by. Sequester Inks and bolts. This ink (also) looks reddish under bright light.

The same Sepiot. comes in again and again and again. In Bar, plain golden (yellow?), and/or Ord+. Always with E or Curl or V-Curl beforehand. Are all these arm positions supposed to be

Quite that dark "cuttle" replace WS!

Cephalopods May 18, 1978, I.

546

(51)

cryptic? I suppose so.

8:53. This animal is now Barium less than before. Usually in Ord +. Presumably it is getting less shy, less frightened of the light.

9:55. 3 Dorys show up. Rather low. Scattered. Reddish in flash light. Apparently paying no attention to Sepiot. Or vice versa. Then Dorys go off. Sepiot remains.

Then a second Sepiot shows up. About 3 ft from first. Both in Ord +. Then second Sepiot accelerates, swimming fast forward, toward first. The latter retreats. Both in semi-Pike. Then separate. Return to Ord +. NOTE: this second Sepiot also was large. About the same size as first.

COMMENT: this is almost the first sign of intraspecific hostility that I have seen among Sepiots apart from courtship. Are the animals more likely to be hostile at night than during the day ???

Both Sepiots continue in neighborhood. But certainly not associating closely with one another.

The second ind. also tends to do CwL before attacking sandline.

A sees this ind. do DM during attack. (NOTE: this sort of DM cannot be designed to frighten predator. It must reflect a certain level of anxiety without being aimed at a specific recipient.)

Stopping observations 9:20 p.m.

May 19, 1978

A starts tow along Manuwa 7:33 a.m. Over coral and to the

Ceph. May 17, 1972, I

347

across channel to Western Festigo.

7.57. Group of 4 small Sepiots 2 ft up in 4 ft of water over TG. All 4 do Split. Then one does Forward V. I can't see color patterns very well as water is cloudy. All inds. fairly light. Presumably with some stripes. At least one with Fin Stripe. A says that one ind. (the smallest) had Yellow with Split & Split contagious? Then animals disappear quickly. A resumes tour.

Finds more small Sepiots only a few minutes later. 6 inds. When I find them, they are approximately halfway up in 5 ft of water over rock and sand. All in Splits. Yellow or PH according to A. Disappear.

At this stage, I was beginning to think that Splits must be a local tradition, but it soon turns out that they are closely correlated with immediate conditions.

C finds the same or another group of small Sepiots almost immediately. 7 inds. 3 ft up in 4 ft of water over sand and TG. When I find them, they are all HD in Ord+. Then one does Downward V, still in Ord+. A photos. The animals retreat. I write notes.

When I look again, a few seconds later, the animals have all gone up to within 1-3 inches of surface of water. Area where there are many TG leaves floating - as usual now or less vertical. And the little squids are minicling them perfectly. All in HD. In Yellow version of Ord+. One goes pure Yellow with Fin Stripe. Then one ind. goes into extreme Bar with very Contorted Downward V. All the inds. just "hang" with little or no forward or backward movement. Then several more inds. show Fin Stripe in in Yellow and/or Yellowish vers.

P P P

Ceph. May 19, 1978, II.

(33)

548'

ion of Ord+. Fin stripes are broad. Almost or actually encompassing upon area of Bottom Quadruple. No trace Belly stripe. Several inds. show brief traces of Double Strake from time to time. More or less superimposed upon or combined with Yellow- and/or Ord+. Sometimes with Fin Stripe. Sometimes without. This hanging in Yellow-plus continues for minutes.

The exceptional case is the ind. in Bar. It continues in Bar. No trace of alternation or combination with Yellow or Strakes. It stops the Contorted Downward V after a while. Hangs in HD. Then does Downward V. Then sample HD again. All in Bar. This is second largest ind., second from end (group is roughly in line, from smallest to largest). Obviously has a mind of its own. It is much less cryptic than the other inds. (whose resemblance to TG Clades is remarkable). But it does at least contribute to the aspect diversity of the group.

Now I notice that the tentacles are partly extended in HD. And the tips of the tentacles are conspicuously dark.

All this mummery seems to be very conscious indeed!

We resume tow 8:22. At 8:40, A finds "group" of 4 large Sep. lots. Low in 10 ft of water over sand and coral. Actually, there seem to be 2 pairs. Members of same pair usually only a few inches to a few ft. apart from one another. Pairs themselves often 6-12 ft apart. Inds of one pair are slightly larger than those of the other. I shall call the first (larger) "X", and the second (smaller) "Chi".

When I first see the animals, both X's are in Dark-Ord+. So is one of the Chi's (the largest of the 2 members of this particular pair, and the nearest to the X's). I shall call this ind. "Chi I". I have no way of

Cyph. May 19, 1978, III.

547

knowing if it is ♂ or ♀. On inspection, I suppose that it is most likely to be ♀. The other Chri (II) is a rather pale Ord+. Both Chris do occasional E's. Then both do DM, either to us and/or to adjacent Squid fish. The cyerpots do not seem to frighten the fish. (Come to think of it, have we ever seen anything obviously frightened by a DM?) The members of the X pair seem to spend most of their time in slight HV (really slight P). Usually with quite conspicuous Spade.

One ind (an X ???) shows trace of Bar superimposed upon Dark Ord+ when A approaches to photo.

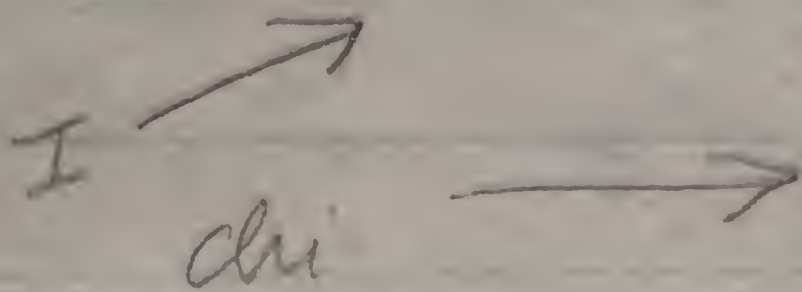
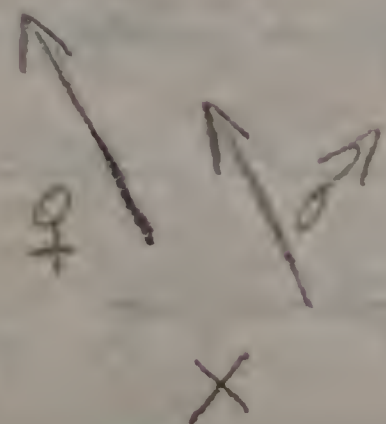
I notice that arms sometimes slightly "uplaid" in E's.

One of the Chris retreats from large fish (Acanthurus) in Pale Ord+ with conspicuous DM. A few minutes later, Chri I does DM in Dark Ord+ with E when another fish of same species passes close by. (There is a large school of Acanthurus in the neighborhood).

There is a single, rather large, Spotted Goatfish below the squid.

The 2 X's continue "P" P's may become more extreme when fishies swim overhead. But none of the inds. is showing any visible interest in feeding.

Orientation of 2 pairs is usually like this



Ceph., May 17, 1978, IV.

530

Chi I is in almost constant E now. I think that this must be intraspecific hostility. Presumably vs. the X's. The E's of Chi I do not seem to vary with our own approaches or retreats.

Then sex nears its ugly head. The X's are Rocking gently, close together. ♂ slightly behind ♀. Still in Dark Ond + (conspicuous PCA) with Spade. ♀ swims forward (forward phase of Rock). ♂ swims forward, after her. Accelerates. Goes into semi-Partial with conspicuous Flutter. ♀ immediately shows partial but conspicuous Lateral Silver - silver side toward ♂. This does not discourage the ♂. He catches up with ♀, probably gets slightly ahead of her, and then "shoots" sideways. Copulation possibly successful. ♀ immediately Flares, shoots backward in social PH (conspicuous dark wording). ♂ also shoots backward behind her.

Then the 2 X's relax. Resume slight Rocking in "P" as before. In more or less Ond+. They certainly seem to be very well adjusted to one another.

Chi I approaches X's once. X ♂ backs toward it. Chi I retreats. No color changes by either ind.

X's continue relaxed as before. Several times, the fins of the ♂'s turn noticeably browner than usual when a fish approaches. Is this low-intensity indication of Dark? (The ♀'s fins remain light transparent throughout).

The fins of X ♂ also turn brown when he backs toward Chi I. Obviously, this pattern is hostile.

Chi I is still in almost constant E. But the X's are still quite calm. QUESTION: the X's would appear to be rather advanced in their reproductive cycle. If so, why are they (still) associated with Chi I? Could both Chis be successor ♂'s ???

Ceph., May 17, 1976, I.

551

We stop observations of these animals 9:05 a.m. A continues tour around W. Frutupo. Out of water 9:30

A starts tour Manan point 11:10 Over street to W. Frutupo. Then along Frutupo itself. I go into water area where cop. seen earlier. 11:28 We swim around. Finally find pair. Almost certainly X's. 8 ft up in 7 ft of water over mixed coral and sand bottom. Both inds. in Dark Dred + with HD. ♀ has remarkably contorted arms. No real V.



Notice DF of 2 short central upper arms.

The ♀ stops contort after a minute or so. The ♂ is hanging a few ft behind her, to one side. He suddenly advances forward in Partel and flutters. ♀ quit hangs or advances a few inches. ♂ catches up with her. Bends. But no cop. attempt. ♀, in more or less horizontal posture, does PH or semi-PH. Definitely with speckled belly. Then both retreat (frightened?) in Pale-Partel. Return a few moments later. In Dred+. Apparently no longer (for the moment) interested in sex.

General comment: ♂'s are obviously ready to copulate more frequently and earlier than are ♀'s. It is the ♀'s who really control the time and place of sexual activity.

I note that the ♂ has small but "permanent" RL. Could this be structural rather than behavioral?

Both animals gradually sink down toward dark tubular gorgones

Ceph. May 19, 1978, VI.

57

552

Still in more or less horizontal Ord+. No HV or Dark. A photos

One ind, the ♂ I think, advances forward toward me. He fairly extreme P or low intensity HV. Barely Ord+ above. Fine certainly more or less transparent. But well marked Bottom Quintuple below. These bottom stripes are displayed directly toward me. Or could this be not "meant" to be cryptic. Nor is it particularly distracting. It looks like threat. This sort of performance probably should be clearly distinguished from the full Quintuples of young that do seem to be intended to be cryptic. Obviously the same patterns, or components of same patterns, can have very different functions in this species!!!

If this sort of performance, by adults, is threat, who is it directed to impress under natural conditions?

The chis seem to have disappeared completely.

A approaches to photo again. ♀ X turns around. Does DM, then Bar, on Ord+, back toward A. At same time, ♂ E's in Ord+.

(Again) ♂ does P (HV) - Bottom Quintuple to me. Then he goes horizontal, with DM on Ord+ back, and retreats, when A approaches closer. I.E. DM contains relatively more escape than Bottom Quintuple with P (and advance).

Now both inds. in HD, Ord+. Add DM when we drift along them.

I get out of water 11:55 am. A tries to slip without seeing anything more of interest.

When we get back to ship, Luchio tells us that there were 12 small leopards at anchor rope!

Go on to Matapo after lunch. Toward swim around both islands 1:55-3:10 pm without seeing a single cephalopod or blob of ink.

Ceph. May 17, 1972, III.

553

COMMENTS: The impression that we got last week, that Sepiots were much more common around the inner islands than around the outer islands, now, would seem to have been misleading.

It is still fairly evident that young Dorps are more common now than during our earlier visits.

Anchor boat in channel between Malunaga and Michauwala at night. Sandius show up as usual. Then, at 5:55 pm, a very large group of small Dorps shows up. Must include 50+ inds. All packed close together.

Apparently all in Ord



Small Dorps come in again several times. SAN.

Back again 7:30. This time there are some medium inds. with group. All still in Ord.

Then we stop observations

ADDITIONS: Gail Irvine says that she watched a group of Sepiots a few days ago (Monday, 15 May). Mediums plus 2 larges. At Tainu (off Malunaga). From her description, it is obvious that the 2 larges were engaged in high intensity courtship. She describes her Pic, Lateral Pelvic (L.P.), and Pencil Flushing.

She also says that she has seen Eupomacentrus partitus attacking (dashing at) Sepiots (probably mediums - i.e. larger than the fish). The squids simply moved off.

May 20, 1948

Going to work along coast between San Blas and Colón.
8:00 a.m. visit site called "Escubanos" at base San Blas Point. A nice bay. Carlos says that water can be clear here, but it is muddy now (there has been a lot of rain recently — in fact it is pouring now). We go on without getting into the water.

Arrive at Nombre de Dios 10:45 a.m. in famous electrical storm. But then rain gradually decreases. Water is very murky indeed.

On to Isla Grande! Arrive 12:50 p.m. Water of channel is very murky. So we explore seaward side 1:05-1:45. Beautiful coral but a heavy swell. No squid visible.

Go on to Puerto Bello in late afternoon. Anchor north bay off far shore (opposite town). Running light at night.

First sandhills show up briefly, 6:50 p.m. Note: water is quite muddy here too!

Then lots of larger sandhills. All very excited, apparently catching very small prey.

Going up 8:45 p.m.

NOTES:

The fact that we have not seen Lollis tonight may suggest that they do not scatter from the shore to feed.

The fact that we have seen only comparatively small Dorops this trip would suggest that they are seasonal breeders — at least more seasonal than the local Lepidotes.

May 21, 1972

Explore Porto Bello area this morning 7:24-10:00 am. Along both sides of the bay and some immediately adjoining stretches. Great variety of habitats. Mostly coral, but also sand, mud, T_2 and mangrove. But not a trace of squid of any kind!

NOTE: Marine fauna here may well be different from that of the San Blas. At least, some of the marine birds are different. Here there are cormorants and Little Blue Herons (as well as pelicans and Great Kingfishers). No Black Terns or Little Egrets (today).

MISCELLANEOUS. I have seen something 4-6 Great Kingfishers always apparently alone. All or most with red breasts. Very great Calittinids, I may have heard a Puffin once. Very different from the African species!

August 24, 1977
San Blas

Arrived by air this morning. (Note: A has been here since Aug. 23). Weather is cloudy but calm.

We start to explore nearby islands. Porvenir, Vieques, Nalunke, a and Sail Rock. Spend all morning and early part of the afternoon without seeing a single squid. The local population seems to be down (in numbers or in depth). A thinks that this may be true of region as a whole. But both Ross and Bob Warner say that they have seen some squids around relatively recently. Ross has been using them as bait!

Ross caught a ♀ a few days ago which had eggs inside.

If the population of squids really is down, it may not be coincidental that the population of Pelicans is up. Pelicans have been doing very well for the last 2-3 years.

Finally go over to Okupukup area in late afternoon. A found group of approx. 27 Sepiots here yesterday. Including large ones which looked as if they might be considering egg-laying. The animals were near the shore of the island which Carlos is now calling "Calobur" (although I am fairly certain that he called it "the other" or "second" Okupukup a few years ago).

We go over to this "Calobur" as soon as we arrive. A starts tow- 5:05 pm. Finds squids immediately. Approximately same area as yesterday.

First squids seen are group of 5 small-mediums. Half way up in 3-4 feet of water over TG flat (some coral heads not far away). 4 of the inds are in Ord with WS and Y (and little or no PCA). The 5th ind. is similar, but slightly on the Yellow side. This semi-Yellow ind. also shows brief Fin Stripes, but only on rear half of body.

It is my impression that this may be typical. It is quite probable that all or most partial Fin Stripes are toward rear.

Then the 5th ind. goes (back) into Ord + like the others. And all 5 inds. retreats without color change, and disappear from view temporarily.

We find them again almost immediately. Very dull in Ord and WS, nothing more. Still over TG. They retreat again without color change. We find them again. Still over TG. Now we see that there are at least 9 small-

mediums in group. And now they are in Ord with WS, Y, and PCA. Several do Forward V's, without color change, in very rapid succession. Are Forward V's contagious? Are all V's contagious? Is this contagiousness typical? In any case, all these Forward V's are slight and brief.

1 (or 2) ind. (s) twin (s) slightly Yellow with a brief retreat. Then the whole group darkens further off. I do not catch the color changes (if any).

A finds group of 5 large Sepiots 20 ft away. Also over TG in rather shallow water. All in Ord with WS. No Y or PCA. Perhaps 1 pair and 1 trio. One ind., presumably ♀, shows brief trace of dark brown "halter" or "collar" — obviously front part of Pied — superimposed upon Ord and WS.

The animals do not seem to be disturbed by our presence. Continue to swim calmly near us. Only very slight and irregular traces of Rocking. One presumed ♂ and one presumed ♀ do tend to stick fairly close together (8" - 2') fairly consistently. The ♀ of this pair has a rather Pastel (blue-ish) tinge to her Ord. The ♂, on the other hand, has a Yellowish cast. This may well be typical of not very active (or not yet very well integrated) pairs. (Again) ♀ shows "Halter" on Ord (Pastel) and WS. (Again) when ♂ comes particularly close.

Then both extend arms and show more extreme PCA without (other) color change.

The ♂ twice shows brief Latent Silver. Light side toward me. Performance presumably provoked by my presence? Silver of side of body is only moderately intense. WS still distinguishable. But Silver above eye on side toward me is very brilliant indeed! Is this a distinct "Silver Eye-brows" display? See also below.

♀ of pair, arms still extended, starts to "writhe" arms. Movement not very extreme or rapid. And arms appear to go WT. Then she advances, not directly toward me. In sort of Upward Pointing Head, Body, and most of arms in light. But tips of longest arms (tentacles?) turned upward. I shall call this "Hook".

I am sure that I have seen this pattern before. Tips of arms (tentacles) in

Hook certainly white. Perhaps only

inner undersides of arms (tentacles?) — which are usually white arms.



way - are exposed ??? (I am fairly certain, however, that some WT performances - without Hook - do involve a real color change, extending to the upper surfaces of the arms or tentacles.)

At some point in this process, the tips of the extended arms or tentacles are spread apart. A sort of semi-V. But it is also, of course, the exact counterpart (and virtual replicate) of DF.

And, in fact, the ♂ does real DF either just before or just after. Without any color change as far as I can tell.

Obviously this pair, previously engaged in low intensity courtship, have suddenly become interested in feeding. Presumably on very small anthozooids, as I cannot see any fishes nearby. But neither the ♂ nor the ♀ Sepiot makes an obvious strike.

I will have to make some additions to the section on feeding behavior in the book!

The ♂ and ♀ of the pair gradually drift away from one another, and from me.

Suddenly the small medusae reappear. Swim close underneath me. All in Ord, WS, and Y. One or two also with PCA. I note that Y is really very golden, with emerald around the edges. Very different from Silver Eyebrows. One ind. also has distinct Z or Flecked marles on arms. (The other inds. certainly do not have these marles.) One other ind. also does brief partial Fin Stripe, again toward rear.

A photos larger. 5:22 pm.

Then we move off. A tours to boat without seeing anything more of interest.

ADDITION: A was trying to follow sequences yesterday. He noted that Fin Stripe often occurs before Z, and that Partel often follows Z.

SAN.

We run lights at night. Some Leligo types show up below sand inis at 17:50 pm. Then disappear from view. Water is becoming murkier.

A also goes for swim. Again SAN.

August 28, 1979
San Blas

Still at Ohkappukip. Very gray day. Very calm.

Start out 8:40 a.m. A tour along shore of island still.

8:45. Finds 2 small medium Sepiots. In shallow water. Mixed area of both TC and coral. I go into water. Now we see that group includes at least 8 inds. Mostly medium. One "pair", apparently ♂ and ♀ almost large.

When I first see the group, they are 2 ft up in 3 ft of water over coral and sand. All in Ind with slight WS. No Y or PCA. I pay special attention to their head pattern. Back of head is relatively dark. Contrasts with light forward edge of mantle. Probably not conspicuous or exaggerated enough to be considered a ritualized "Head Bar". Area between eyebrow ridges is relatively light in color.

One ind. does Y with brief retreat.

One ind. does DF as it swims diagonally upward. Presumably for feeding. Presumably on copepods? No visible strike.

Now I see that pair of semi-larges is showing traces of low intensity courtship. These animals must be relatively young. Is courtship sometimes prolonged in this species?

Perhaps I will have to modify my description of courtship in the book.

NOTE: this is almost exact same place where we have seen high intensity courtship among full adults on many occasions in previous years. Obviously an ideal environment for courtship (if not for egg-laying). Why? Relatively protected (less dangerous than reefs in deep water)? Halfway between TC and full reefs?

The 2 inds. of the pair here today are swimming together rather placidly. No real Roaming. As usual, it seems to be the ♀ who is controlling the movements of the pair most of the time. But the ♂ does swim forward to her occasionally, apparently on his own initiative, and she does then retreat from him.

NOTE: the size discrepancy between the ♂ and the ♀ is appreciable. Apparently there is seldom or never any confusion of sexual roles in this species (??).

The ♂ has slight RL all or most of the time. The ♀ has large RL. Sometimes this is unilateral. Once, at least, the white or silver of her RL briefly spreads forward over half the body. As far as I can tell this is not accompanied by any trace of Halter. Front part of body swim

arms in Ord & WS.

Then both inds. of pair show (more) traces of feeding. Advances upward with DF (at least once) or slight trace V at tips of arms or tentacles (at least once). Definitely no WT. No Hooks. No struts.

Then back to mild courting again.

The ♀ seems to have had trace of Belly Spitting, on each side of body below fins, throughout. I suppose that this pattern must be hostile in motivation. Perhaps related to Z. Have I put it in the right table for the book?

Neither individual shows any trace of Border at any time. Nor have any of the other inds., small medium to large, courting or non-courting observed yesterday or so far today. Borders do seem to be relatively rare. It is not just that we have been overlooking them.

The pair gradually drift away. A follows them to photo. The ♂ and ♀ are still more or less together. Still in Ord & WS. ♀ still with RL. Perhaps Belly Spots have gone. I can't see if ♂ has RL or not. The ♀ suddenly performs long and elaborate Writting without color change.

I get out of water 7:05 a.m. Pouring rain. A stays behind for a few more minutes to continue photos.

COMMENT: I think that the performance that we have been calling "Pied" may be compound. Comprising at least 2 elements. The Silver "flunk" and the Dark Halter.

It is interesting that "Silver", Pale, and Partial are so similar in appearance despite their very different effects and motivation. Is this another example of the "confusion principle" (i.e. that similar patterns look different while different patterns look similar) ???

Rain continues all morning.

We finally start out again 12:23 p.m., just as rain stops. A tows along Okkoppukup. Out along reef. Then back again. Sees 2 large Sepiots 12:47. They disappear immediately. A resumes tow. Sees 3 medium large and 1 smaller Sepiots edge reef. They also disappear immediately. Tow resumed. A sees large numbers of small Ink blobs, but no animals. We finally give up 1:55 p.m.

Go on to Rio Sidra area.

A starts tow along mangrove islet 4:15 p.m. Water too murky. Then tows out over offshore shallow. One brief glimpse of a medium Sepiots over coral. Nothing more. We finally stop 5:25 p.m.

NOTE: There have been very few pelicans around today. Why? Perhaps most of the prey has gone down into deeper water, discouraged by the rain and reduced salinity at the surface?

REMARK. As far as I can remember, I forgot to mention, in the book, that young Sepiots like anchor ropes and pilings. Possibly for protection against predators.

Running lights at night. Off Mursatuppi, the nearest island to main land here. Only a few Loligo types come in from time to time. Apparently the Loligos are also down now.

IMPORTANT. A says that Ann Holm identified a single Loligo collected at Panetupo during our last "joint" trip as roperi!!!!!! This means that I will have to re-write the whole of my section on Loligo associates - plus all the back and forth references!!!!!!!

August 27, 1977
San Blas

Still in Rio Piedra area this morning. Weather is improving. Sun coming out.

A starts tow around Urbanti 7:55 a.m. Finds many large blobs of ink 8:00. Area of TB. I go into water. We find group of approximately 25 Sepiots. Ranging from large to medium. Graded in diagonal line. One end is formed of ♀. ♂₁ next. ♂₂ next. Largest medium next, etc., etc. (I suppose that it is characteristic that ♀'s - rather than ♂'s - are "end of the line" more often than not. Obviously advantageous from the ♀'s point of view.)

The ♀ and the ♂₁ form a pair. ♂₂ does not seem to be greatly interested, for the moment.

All inds. are in Ord + WS at first.

The ♀ and ♂₁ are at the end of the line that is farthest from us. Both ♀ and ♂₁ assume E postures, backs toward us. Both show DM's edge of body. (Not extending to fins - I think). ♂₁ with conventional pair of spots. ♀ definitely with 2 pairs (near largest) DM's combined with otherwise unchanged Ord + WS. Then both inds. swim forward. ♂₁ accelerates. Apparently "brumps" into rear of ♀ with tips of his tentacles. No visible color change (can't see DM spots from this angle). This encounter does not look like a copulation attempt. Or even aggression. Could it have been purely

accidental?

Then the whole group swims away from us. In Ord + WS (can't see if there is any Y and/or PCA). One of the mediums shows near Fin Stripe as it goes.

We catch up with the 3 larges a few seconds later. (The mediums have gone elsewhere.) The σ_2 is definitely associated with the ϕ and σ_1 , but he still seems to be very inactive. The ϕ and σ_1 do some E in Ord + WS. A advances to photo. The animals retreat again. We find the ϕ and a σ a few seconds later. Presumably this is σ_1 (σ_2 having drifted away). In fairly shallow water over TG. ϕ is in P with double DM. Back toward us. This becomes 2-Bar (both bars across body). Then 3-Bar (tail end dark).



(The back of the head is also fairly dark, but probably not distinctive or exaggerated enough to be called "Head Bar".) I can't see what pattern (if any) may be on the underside of the ϕ . The σ is sideways to us. In normal posture, Ord + WS above, and a trace of Bars (2-Bar?) below.

Both animals relax as A backs off. Then they both swim further away. A advances again. Both animals in Ord + WS. No Y. Probably no PCA. In normal postures or "TD" (Tail down) see below.

I get out of water 8:23.

COMMENTS: These animals are obviously not very highly motivated. Yet they certainly seem to be paired. This may be further evidence that pairing starts early. And that pairs precede as well as follow parties!

It is interesting that these animals did Bars rather than Stralis over TG. Why? Because the patterns developed from DM? Is this (further) evidence that Bars are slightly more "aggressive" (contain slightly less relative escape) than Stralis?

A resumes tow 8:22. Finds 2 large Sepiots 30 ft down edge coral. In Double Strake above. Perhaps also with Fin Stripe. Near gorgonians. Presumably cryptic. But they go away immediately.

A resumes tow. Finds 2 more large Sepiots, near net poles, in 20 ft of water over sand and coral. Engaged in courtship. And apparently one copulation! Unfortunately these animals also disappear before I can get into water or A can photo.

COMMENT: If this copulation was real, this pair of Sepiots would

seem to be considerably more advanced than the rest of the population.

We go back to boat 9:20 a.m. Start out again 9:50. A tours around Musatupo. 10:01. Find group of 10+ smallish Sepiots in 3 ft of water over TG. In Ord, WS, Y, and PCA. They drift close by me. Some inds. show Z type marks on arms and/or Belly spots at the moment of closest approach to me (9.2. these patterns must be interspecific in this context.) Then the group pauses a few ft. from us. Several inds. do P. Several do "AV" (Arms up). In this latter pattern, the arms are raised as in P, but the body remains more or less horizontal. One ind. does bottom half Quadruple in semi-P. Another ind. does bottom half Quadruple in complete normal posture (no AV) as it switches from facing away to facing toward us.

A photo again. The group goes out into deeper water. A resumes tow 10:10.

Find more Sepiots almost immediately. In fairly shallow water over TG. 18(+?) inds. Ranging from large to medium. They retreat before A. When I get into water the nearest inds. are low, almost in TG, in 1 ft water. I see a trace of (♀?) RL. Then the animals retreat again. Then we catch up again. Now all the inds. are in Ord + WS + Y + PCA.

One more retreat and one more catch-up. Now we see that 3 of the largest are a definite trio. Again at end of line. Again ♀ farthest out. In semi-Ord +. Swimming back and forth in semi-Rocking. All very low intensity.

♂₁ shows trace small RL.

Now we notice that the Ord of the ♀ has become definitely blue-uli-purpleish. Still with WS. ♂ has become yellowish. Still with WS. And with WB.

COMMENT: this ♀ - blue vs ♂ yellow dichotomy probably is typical. Is it evidence of color vision??? In any case, I probably should recognize "Blue" as another distinct ritualized pattern of the species.

A goes in to photo. Animals retreat toward me. ♀, ♂₁, ♂₂ all in Ord + WS + Y + PCA now. (Still) swimming back and forth together. Several times, during the backward phases (initiated by the ♀?), the ♀ lowers several arms on the side toward the ♂₁. At the same time, the lowered arms show traces of Z marks. This is reminiscent of (♂) Sepia officinalis.

One ind. has 2 white scars toward rear of body. Look like "White DM". But certainly not display.

Several inds. (not the adults) do P near me. Low in water over TC. One shows bottom half of Gunituple in P. Side stripes continued into arms.



The other inds in P are "baw" (unpatterned) below. All inds. are Ord + WS + Y + PCA above. All inds. in P, irrespective of pattern below, are facing me, i.e. "exposing" undersides to me.

I stop 10:30 a.m. A goes back for another session of photo. Without seeing anything more of interest.

COMMENT: I wonder if I should distinguish between "P", AV, and TD in the book? Or at least between AV and TD? Or is the difference purely contextual?

In the afternoon, we go to Morpetuppu. Explore all around island and then along offshore bank. No signs of squid.

Then on to Teatupo, where we anchor rather far offshore for the night.

ADDITION: A says that he saw something very surprising here, on his last trip. Groups of Sepiots in water off sand slope. Ranging from small mediums to larval or almost larval. Stratified. Largest on top. Smallest further down. 30 ft down!? Quite a lot of inds. of smallest class. But scattered. SAN

Ran lights at night. Nothing of interest. Only a few Loligo types far down in water.

August 30, 1979
San Blas

Still anchored off Teatupo. Sunny and calm.

7:50 a.m. 2 small Sepiots show up at anchor rope (there may be others further down). At first rather far apart. One almost at surface. The other 1-2 ft down. Both in Ord + WS. Both usually (not always) with tails toward rope, heads facing outward. Then the lower ind. comes up, apparently very close to its "companion". At approximately same time, this former turns rather bright yellow, apparently all over. Yellow with little or no WS. (This change in color may have been initiated by shaking of anchor rope by Lucha - but I rather doubt it.) The former then alternates long periods of Yellow with shorter periods of Ord + WS. Obviously feeding on tiny prey during Yellow phases. The latter

ind, the "joiner", apparently does not feed. Still in Ord + WS for a few minutes then gradually gets Dark(er). Until its WS (also) almost or completely disappears. The contrast in appearance of the 2 animals is very great.

Is this contrast protective? Is it a consequence of the rapprochement of the 2 inds.? Is there a general rule involved? The closer together, the greater the contrast? And the greater the unpredictability?

We start out a few minutes later. A begins tow around Triatipo 8:12. Along near side. Shallow TG flat. We see large Barracuda. It swims off and disappears. A few secs. later, A sees Ink blob in water. Then more blobs a few m. further on.

We swim around and find group of 30+ Sepiots. In line. Very well graded by size. Medium to very small (but certainly not "larval") All facing us. All in Quadruple (or, in some cases, Quintuple). All in P, AV, or TD. Of course with WS. Some, at least, of the inds. seem to have Y. Perhaps also PCA.

There do not seem to be any Fin Stripes with these Strualis. Nor any "Borders" to fins. I notice, in fact, that fins are almost transparent. While body at base of fins is very light. (This is, of course, one of the causes of the streak effect.)

2-3 inds. turn completely Dark, retaining Double Strake above, when they rather suddenly go into more extreme P.

A photos and I back away. Then I drift closer again.

Now these squids are retreating, slowly, before A. Only a few ft. Surprisingly, a few inds., then more and more, go out of Strualis and it Ord + as they retreat (Perhaps because they go completely horizontal, in "normal" posture, and Strualis would not be cryptic in horizontal???) Fin gradation of size seems to break down during retreat. But then the animals pause. And gradation is rapidly restored. (This is typical, I think.)

A sees larger Sepiots in distance. He goes to investigate. I stay behind with the group of smaller. All in Ord + WS now. Some Y. No PCA? Then group seems to get nervous. Brief retreats by several inds. 2 of the inds. uns do brief "bottom Quadruple" before retreat. Then whole group drifts off. Out of sight.

I go over to join A and group of larger Sepiots. 10 large mediums or small larges. Plus 2 very larges. These latter are at end of line - a semi-detached pair. Again presumed ♀ is furthest out. All inds. in line, all watch

ing us intently. One in AD (arms down, body horizontal). The rest in P or AV. (Again notice "odd man out" effect) All the mediums in P or AV are Dark below, except for one who has light belly with Belly stripe (another odd man out!). Both the ♂ and ♀ of the pair of very larges shows Bars (3-Bar) with center stripe (presumably this is related to simple Belly stripe?) below. The Bars of the ♀ are more conspicuous, better developed, than those of the ♂. All of the inds probably are Ord + W₂ or Dark-Ord + W₂ above.

All the inds are low in 3 ft of water, almost into TG. Dark is not cryptic in these circumstances.

I back away as A goes in to Photo again. Uses flash. No visible response by squids. Not even retreat. This group is very tame. Perhaps we believed that we drove Barracuda away? In any case, it is obvious that Dark is not alarm pattern. Nor can it, in these circumstances, be only an indication of rest or relaxation. The animals are obviously very well aware of us.

I am interested to note that we have not, so far, seen any Upward Curves or E's. This may be a further indication that the animals are not particularly frightened of us.

But then - speak of the Devil - A moves off. Immediately one of the mediums does brief E. But it is not repeated.

I approach one of the very larges (♀?). Still in P with Bar below. Facing me (displaying belly). Then suddenly switches around, still in P, to "present" side to me. At same time, drops Bar and assumes bottom half of Quadruple below. Still in P. Light Ord + with conspicuous ocelli above.

This performance must be designed to be baffling or disconcerting!

I am sure that this animal showed no trace of Borders at any time, either with Bars or Stripes.

NOTE: Perhaps I should add "ocelli expansion" to my list of ritualized patterns in the book?

We stop observations 8:55 a.m. Back to boat.

Start out again 9:20. Explore Panatupo, Piriatupo, and Guringuntupo without seeing a trace of a squid. Stop 10:55.

COMMENT: Obviously the population is down now. But most of the few groups that we do manage to see are still fairly large. I.E. the species is really gregarious during the daytime, at any population level.

In the afternoon, we go on to Matupo. Explore both Matupo itself and "Little Matupo". A finds group of 4-6 large Sepiots in shallow water over

coral reef, but they disappear immediately. And we can't find anything else.
So we go on to explore large reefs off Pohnpei. Bob Plummer says
that he has seen lots of squids there recently. But again we can't find them.
A third go around Malakal. Starting 4:40 pm. Find 5
large squids. Not doing much. Photos

John
W

Leptenthus cinnamomea

Guam,
March 16, 1979

Going exploring today

Start out Piti channel, near power plant 11:25 am. Intermittent rain and wind. Some wind. There is artificial channel, but not very recent. Sand bottom with some "rubble", coral (not very impressive), brownish weed, quite a lot of *Neodiloma* on sides. Apparently squid are seen here with some frequency. We swim until 12:35. I see 2 small black fish, but that is all.

Go on to Luminas reef. Into water 12:50. Lots of fish and coral (*Acropora*). Very pretty but no squid.

Then on to southern part of island where there are grass flats. The local grass is *Eulalia*, not *Thalassia* (*Thalassia* is absent from Guam, why?). Actually *Eulalia* looks very much like *Thalassia*, but it is coarser, wider (latter) and coarser. Here it grows in clumps. White sand between clumps. We go into water 2:40 pm and I swim around for a half hour or so. Again no squid.

NOTE: I was contemplating the fact that there are no *Leptenthus* on Pacific coast of Panama when Chuck reminded me that the Great Barrier coral also is absent from same region. He suggested that this may be because young spend a year or so in TG, and TG is very scarce on this coast. Perhaps the rarity or absence of TG is also discouraging to *Leptenthus*?

Guam,
March 17, 1979

Going to try Piti channel again today. Sunny, but much wind. I

Ceph., Mar. 11, '79, I.

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go into water 10:10 am.

See groups rather small sardines almost immediately. They are not closely packed (i.e. not being chased or preyed upon at the moment). There also are Halfbeaks at surface. Also quite a lot of goatfish near bottom. Species looks rather like Spotted Goat of Panama, but only one dark blotch at base of tail and a longitudinal dark stripe along side. The first few inds. seen are more or less alone, but later on I see groups of 8-10 inds.

There are no squid with any of these fishes.

Finally, 11:13 am., I find group of 3 Sepiots. All more or less medium. 3 are quite small. 2 appreciably larger. In line 1-3 ft apart. Smallest ind. nearest to me; largest inds. farthest away. 8-10 ft down in 12-15 ft of water over sand.

They look incredibly like sepioides

When I first see them, they are all in "Ord + " Typical Ord color on back. Apparently at least some WS. Also PCA and a trace of Spade. At least 2 inds have definite extreme Y (but this looks very silvery in this light).


The 2 nearest (and smallest) inds. do E, presumably to me, in Ord +. One of them shows trace of V in E. This same ind. may also show trace of Dark, very briefly, in its E. E's come and go, but several times maintained for a minute or more.

None of the squids seems to pay any attention to mixed group of fishes a few yds away.

I turn my eyes off the squids in order to write notes. When I look back, the 3 nearest inds. are all in general Dark. Little or no WS (definite). Their arms are stretched, elongated, forward to a moderate degree. They retreat (possibly from fear?) a few feet.

Ceph., Mar. 11, 79, II.

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One of the inds does E with tail down.  With definite but not very extreme Bell Bar. Then back into ordinary posture with some "flicking". Rapidly but irregularly paling and darkening. Relatively little WS at any time.

The 2 largest inds. have drifted off and disappeared from view 11:25

The 3 remaining are floating quietly, 2 facing me, 1 facing sideways. All in Dark. (Again or still) no WS. All 3 retreat briefly.

Then 1 ind. starts what looks like feeding. On very small prey. Cepapods? Makes several short advances. No real strikes. Back in semi-Ord. Arms stretched forward. Apparently arms have dark tips.

I get out of water 11:30 when other swimmers arrive.

Go back to same area 1:15 pm. Swim until 2:15 pm without seeing any more traces of squids. Perhaps because the swimmers are still around.

Guam,
March 12, 1979

Exploring new areas today going by boat to the south along the west coast. There is considerable rain early in the morning but it stops around 10:30.

11:45 am. Reach Sella Bay. Sky is still overcast and there is very little wind. The water is unusually calm for the area. I am told that squid are often seen here near the reef margin.

Go into the water immediately. Swim over coral "plain". A great many fishes of many species. Including lots of murex. Rather dispersed.

12:10. Buhlund sees 2 large Sepiots. I swim over immediately. Find that the 2 inds. are engaged in elaborate behavior.

This would appear to be egg-laying.

Ceph., Mar. 12, '79, IV.

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Although both inds. are large (more or less comparable to the sepioides of Panama), one is considerably larger than the other (perhaps 10-15%?). And surprisingly enough, the very large ind. seems to be ♂, while the slightly smaller ind. seems to be ♀. (I shall call them "♂" and "♀" without qualification, even though I can't actually prove their sexes.)

When I first see them, the 2 animals are swimming together (6"-1' apart) very near the surface of the water (perhaps 8"-1 1/2') down. Substrate is exceedingly uneven. High coral heads, reaching to within 3'-5' of the surface, interspersed with deep caverns, holes, and ravines which go down to 12'-15' below surface.

What the animals are doing is repeatedly visiting a particular site 8'-10' down in a ravine, and then retreating to the surface again between visits. Unfortunately, due to the form of the coral heads, and to the fact that I am caught in a strong current, I cannot see what they are actually doing during their visits. But the ♀ certainly enters or inserts her arms into a hole or crevice. While the ♂ remains hanging in the water near her. Hole is 8' down.

Each time they go down, the ♀ takes the initiative and leads the way. When they come up again, the ♀ also takes the initiative. But she does not usually lead. The ♂ waits, hanging above and behind, while she goes to or into hole. Then he starts up a second after she does. But this means that he is going "before" her.

Most descents are forward. Most ascents are backward.

When the animals are at the surface, they swim quite placidly. More or less back and forth over a small area (a few square meters). Always close together. Perhaps a form of "rocking", but much less exaggerated in form than the full Rocking of sepioides. Perhaps not ritualized.

At this time (i.e. high in the water), the ♀ is always, and the ♂ usually,

in a not very remarkable color pattern which resembles Ord (or which is, perhaps a form of Ord). A moderately dark, rather uniform (not conspicuously mottled or spotted) yellowish-brown, at least above. (Belly must be lighter, perhaps colorless). I shall call this color pattern "Yellow-Ord" (in contradistinction to "Gray-Ord" - see below). Perhaps homologous with some of the "Yellow" or "Yellow-PH" patterns of sepioidea (especially as performed by some ♂'s during some courtship).

Yellow-Ord may always be accompanied by some slight (thin) trace of WS, but I cannot be sure of this. Certainly whatever WS may exist is usually much less conspicuous than usual WS of sepioidea. But the ♂ (at least) may "flash" a much broader and more visible WS (especially on rear half of body) from time to time. This may be a reaction (alarm?) to approach by me.

The ♂ also combines other patterns with Yellow-Ord while high in the water. Sometimes Y (again I notice that this is more silvery than golden). Very often PCA. And PCA is often accompanied by other components: Pale Outer Arms (POA); Bulging; In-and-out waving ("Waving"); and, less frequently White-tips ("LWT").

PCA seems to be essentially identical with corresponding pattern of sepioidea.

Bulging is a position of the arms. Obviously strictly homologous with Spade of sepioidea. But rather different in shape.



rather than



POA occurs with PCA, with both Bulging and Waving. The outside arms are white or nearly so (like PCA). The net result is that the cluster

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of arms appears to be semi-striped. More or less common.



Very diagrammatic!

Facultative LWT

The LWT looks like the WT of sepioides. The tips of some arms (in fact, presumably the tentacles) are slightly protruded and turn brilliantly white at the tip. In the case of this Uronomus ♂, however, I find it difficult to believe that the pattern is a "decoy" or has anything to do with hunting. Rather it seems to be an integral part of the cluster of associated patterns. Probably hostile. See below.

Waving is a more remarkable performance. In this pattern, the 2 outer arms are waved in and out. Usually or always synchronized, i.e. together.



This may well be related to the "Winking" of sepioides. But it seems to be more regular or stereotyped, presumably more highly ritualized. It may be the brightest intensity component of the whole PCA, POA, Bulging, LWT series.

The ♀ certainly showed at least a trace of PCA (and of Bulge?) most of the time. Also brief and rare flashes of Y. But she never did Waving. And I don't think that she ever showed LWT.

When the ♀ went down on a visit, she retained her Yellow-Orb (sometimes with minor accessories). Nor did she change when coming up from a visit.

The ♂ was much more variable. He sometimes assumed Bar, at least on the back, as he went down. He almost always assumed Bar on the back as

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he came up (only resuming Yellow-Ord +) when near the surface. Bar on back comprised 3 rather blotchy transverse bars across back (probably without any trace of DM on fins), a dark bar across top of head (usually or always interrupted by Y of eyebrows), one dark bar about a third of the way down the arms, and (usually) a final, interrupted, dark bar about two thirds of the way down the arms (i.e. not far from the tips). So far, this is probably quite like the corresponding pattern of sepioidea. But the general effect of the linomama performance seems (to me) to be slightly different. Not only are the bars themselves particularly blotchy (of var. irregular widths), but a faint trace (a smudge) of the 2 longitudinal dark streaks on either side of the "WS" usually or always remains throughout.

I certainly saw some slight (small) RL at various times during this series of actions and reactions. With Yellow-Ord, probably by both ♂ and ♀. Possibly also continuing with Bar of ♂.

Unfortunately, from my angle of view, I could not tell if the ♂ had Bar on belly at the same time(s) as on back. I should think probably yes, at least in some cases.

I did, however, look up once from writing my notes, to see the ♂ in a "head up" posture with full and extreme Bar across belly (possibly also dark center streak ???). But unfortunately I couldn't see his back at the same time.

Another time, the ♂ ascended after vent with E as well as back Bar. On still another occasion, he flashed WS, in Yellow-Ord, with retreat after an ascension. This "flashing" may well be an alarm signal.

Which brings up a general problem. What in the world was the point of all this display by ♂ ??? He did not seem to be trying to influence the ♀ directly. This did not look like courtship (which would not be expected in

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the circumstances anyhow). All I can suggest is that he was trying to frighten or distract me. Perhaps the ♂'s of this species are more useful during the egg-laying process than are the ♂'s of sepioides??

I finally get out of the water 12:45 pm. Shaking with cold.

Before this, between Chuck and myself, we had seen at least 20 vents by the pair to the presumed nesting hole. And they still seemed to be going strong when I left. Perhaps the clutch of this species is comparatively large?

Then we go a little bit farther north, to next point (name unknown, but just south of Jacpi Point). I go into water 1:23 pm. Clear water over enormous mounds of coral, separated by strips and patches of white sand. One of the graduate students see 2 large squids from boat, but I miss them somehow.

But then I see a group of 6 medium squids. Ranging from rather small mediums to rather large mediums. Nicely graded by size in diagonal line. 3 ft down in 10-12 ft of water. Facing me. Moving slowly backward over both coral and sand.

These inds. are in a kind of "Ord" distinctly different from the Yellow Ord of the adult pair seen a few minutes earlier. This version is generally medium dark gray-brown above. Brown is thickly speckled with rather large (oval) white spots. I shall call this pattern "Gray Ord" for the time being. Combined with definite WS. Also conspicuous silver-white line along upper front border of mantle. I shall call this "WML". All the inds. are very pale, perhaps more white than colorless, below. All have at least a trace of PCA. Possibly also (silver) Y. But almost certainly no Bulge.

The ind. nearest to me does brief but conspicuous fin stripe during a brief squirt in its retreat. Very sepioides-like.

I suppose that the Gray Ord of leucostictus is more likely to be strictly

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homologous with the usual "Ord" or "Ord+" of sepioides than in the Yellow Ord.

Most of the inds. have transparent or semi-transparent (brownish gray) fins with their Gray Ords. But one ind., a relatively large one, keeps its fins more or less white throughout. Unusually more or less milky. But sometimes the fins flash suddenly whiter (or brighter). They may also, conceivably, be fluttered rapidly at the same time. Could this be related to the Pastel-Flutter of sepioides a? Could it be an alarm pattern, like the "flash" of the WS??

None of the inds. has a distinct border (BB or WB) to its fins at any time.

Three inds. drift off out of sight. I get out of water 1:45 p.m.

We go on further north, to a site called Minutz Channel. Much the same environment as at previous site. We swim around until 3:00 p.m. without seeing any more squid.

NOTES: I have been talking to John Eads, one of the technicians at the lab here. He seems to be quite familiar with the local squids.

S. lesoniana seems to be the only inshore squid here.

Presumably separated from Lepidoteuthis by differences in depth preferences.

Eads says that he has seen group of approximately 15 young squids, presumably lesoniana near surface in deep water (40 ft) over smooth bottom at a place called Blue Hole.

It seems very likely that the young of this species do not congregate in nurseries on grass flats here. (Eads has never seen them on the Cocos flat.)

Eads also saw a pair of adults engaged in courtship (and/or copulation) at the mouth of the Pago River near the lab.

COMMENT: this species is very similar to sepioides in many respects. But it probably differs in some aspects of ecology, and in details of both

social and anti-predator behavior

Guam,
March 13, 1979

CORRECTION. It turns out that the animals seen to be courting or copulating at the mouth of the Pago River a few days ago were octopi, not squids! Not everyone here seems to be sure of the difference!

Be that as it may, we go to the area in mid-morning. Start to swim 10:30 am. It is sunny and windy.

Near the shore the bottom is sand and "mud", with occasional small patches of grass. There is some murk in the water. (Actually, this may be an area of slightly reduced salinity.)

We reach large coral heads, where the octopi were seen a few days ago, 10:45. Water is clearer here. The bottom probably is 15-20 ft down, but the coral heads come up to 2-3 ft. below the surface.

See a single octopus almost immediately. Probably quite large, but mostly hidden in a hole in upper part of a coral head. The exposed parts of the body are yellow-brown, corrugated and bumpy, just like the surface of the surrounding, or enclosing, coral. This is very good crypsis indeed.

(Mike Parker, the student with me, who saw the animal a few seconds before me, says that it was red before going cryptic. This may be significant. See below.)

I go on a little but farther. See another octopus. Quite large (head and body 12" ?). Sort of vulgaris-type, but God alone knows what the particular species actually is. When first seen the animal is ~~seen~~ sitting fully exposed 6-7 ft down on top of yellow-brown coral head. 10:53 am.

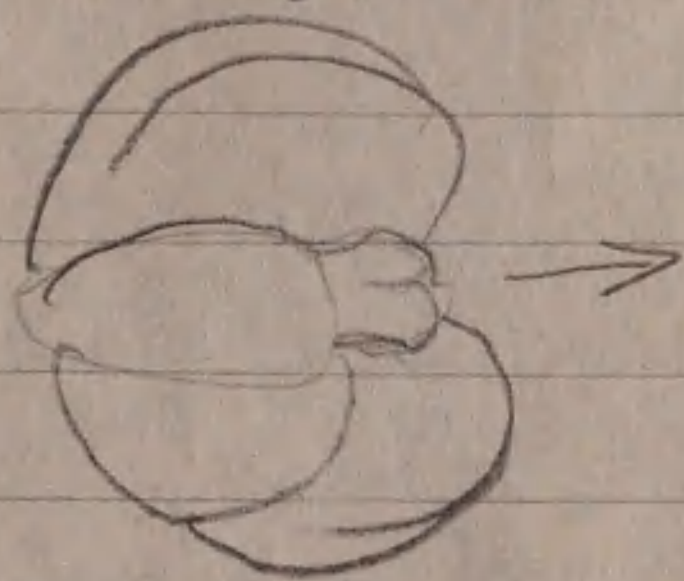
The animal is generally pale cream in color over the whole head and body. Same color extends to, or into, base of arms. Skin is rather like crepe in texture. Most of the arms are slightly darker. Yellowish (perhaps olive-ish) with faint darker transverse bars. More or less tucked around body. The animal also has the "horn" above its eyes erected. Blunt rather than pointed. \mathcal{R} The pupils of the eyes are very narrow, hardly visible.

After a few seconds, the "horn" disappears, retracted. At the same time, the skin becomes much more uneven. Papillae erected all over body and top of head. I shall call this "tubercular". No color change for the moment.

Then the octopus is attacked by a small blackish pomacentrid. It responds by flashing white. Then resumes previous cream + coloration.

COMMENT: White does seem to be the, or a, high intensity alarm color in all or most coleoid cephalopods. Or, if not white, at least pale or paling.

Then the octopus starts to move slowly. More or less parallel to me. Still cream and tubercular. Arms still tucked around body.



No trace of DM anywhere

Then the animal moves up side of adjacent coral head. Suddenly extends or spreads all arms. At same time goes "Lateral Red". One half of body and head (the right half) goes a rather brilliant maroon red. So do the 4 arms of the same side. The other half remains cream for some seconds. Then also goes maroon. (I shall call this pattern "Full Red".) Arms still extended. And head and body still very tubercular (I think).

Then the interbranchial membranes suddenly flash light or white,

Ceph., Mar. 13, 1979, III.

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while the rest of the arms, and the head and body, remain maroon. This is very brief. Then the whole animal turns Full Red again. Definitely (still) Sub-circular at this stage.

Suddenly the animal pours itself down a crack in the coral and disappears from view.

Comes out, higher up on coral head, about 2 mins. later. Now it is yellow brown and lumpy all over. Settles down in saucer like depression at top of yellow brown lumpy coral. Cryptic like the other ind. seen earlier. Head, also yellow brown and lumpy, usually raised to look at me. No Horns.

Suddenly the area is invaded by several other human swimmers. Each time a swimmer comes close, the octopus "sinks down", pulling its head down. But then raises its head again as soon as swimmer moves on. No change in color or texture.

Finally the animal oozes away and disappears as if by magic.

I move on, but do not find any more cephalopods. Out of water

12:05 pm.

COMMENT: Obviously this species, like many other octopods, can use 2 different anti-predator strategies. It can try to startle and/or frighten a predator. Or it can try to hide, to disappear from view, in fact or in visual effect. The 2 inds. seen today tried both strategies, one after the other. Is it coincidental that startle or threat was used before cryptic in both cases? If the sequence is regular, why is it adaptive? Is there a protean element involved? If so, how?

Guam,
March 14, 1979.

Ceph., Mar. 14, 1979, I.

(13)

There is quite a large octopus in tank at the lab here. Possibly the same species seen yesterday. Sitting on bottom. In usual octopus style. But this individual looks particularly inert. Perhaps not in the best health.

Generally light pinkish brown all over. Round or oval white spots on arms. Becoming broader and fainter (to light bars) at very base of arms and on interbrachial web. Head, body, and web also covered by dark red "Reticulation" network.

This seems to be fairly cryptic in the tank.

As far as I can remember, it is also very much like the vulgaris described by Packard.

We go into water in front of lab in afternoon 1:40 p.m. Rocky coast. Sepiots have been seen here on several occasions recently.

Swim over quite a wide expanse of coral and rock bottom. Unfortunately there is a fairly heavy swell, and the water is not particularly clear.

1:46 p.m. Catch very brief glimpse of small Sepiote 3 ft up in 1 1/2 ft water. In some sort of "Ord". Disappears immediately.

We continue swimming until 2:30 p.m. without seeing anything more of interest.

NOTE: According to one of the graduate students here, Denny Lassus, the Sepiots are most common at this site later in the dry season. Late April to (approximately) July.

Colonel Moore also says that some of his divers saw Sepiots at a place called Gun Beach, on west coast of the island, a few days ago. And that this is the time of the year when the squids usually begin to show up.

All this would suggest that the local Lemoniana may well be seasonal. Moore has never seen any contact between Lemoniana and Sepia latimanus. The segregation between the 2 species must be nearly perfect.

Palau,
March 14, 1979.

Spent the last 2 days travelling, making arrangements, and also looking at kungfisheries.

Arrive here at Mariculture Station (Malakal Island) ca 11:00 a.m.

Almost immediately see large group Sepiots from edge concrete breakwater. Approximately 60 inds. Near surface in 5 ft of water over white rock and sand bottom. Inds. look medium to large. Jumbled, facing in all directions, but quite close to one another. Perhaps 2"-6" apart in most cases. All in dark. No

WS visible from above the water. Apparently "basking" like sepioteuthis. (Sun is hot and bright. Just enough wind to ruffle surface.) The inds. are very conspicuous against light bottom. But presumably they are deep enough to be out of reach of predatory birds. (NOTE: the commonest subtidal seabird around here is the White Noddy. The next most common is the Brown Noddy. They probably are too small to be dangerous to large Sepiots. But there must also be things like boobies around.)

There also is a school of minnows right at surface. Breaking water. Some of the nearest Sepiots may be feeding on these fish. Or at least making out moves of feeding toward them. This is not accompanied by any color changes visible from my point of view.

NOTE: the people here say that squid are abundant around lab. I am willing to believe them!

Then I get distracted by stolen Travellers Dugue. Finally go into water. Start again ca. 2:15 pm. Quite a lot of people around. Swimming in water. Also fishing (poles) from bank. I walk along side, looking for the squids. They are not exactly where they were earlier this morning.

But then I see them (still from bank) some yards further on. Quite a large group (at least 20, but difficult to count). Medium to large inds. Strung out in diagonal line from largest to smallest. Quite close together. All apparently (still) in Dark, at least above.

Enter water 2:30 pm. At a point rather distant from squid. Swim in their direction. Water is slightly murky. Lots of fishes. Abundant types, pipefish, etc. Also many large schools of minnows and sandules of various sizes. Some dispersed. Others in very tight schools.

Reach area where squid seen earlier 2:40. Several smallish blobs of ink in water but the squid seem to have gone. Perhaps because of the fishermen.

NOTE: there are large numbers of holothurians, Diadema, and Tritonia (all sizes) in this area. I.E. the water must be full of miscellaneous eating matter. Euphausia murkiners

2:51 Finally catch very brief glimpse of squid in "distance". Possibly same group seen earlier. 20+ inds. Halfway up in 8 ft. of water. Over some sort of "grass". (A plant that I have not seen before. Short, with rounded or globular leaves.) The color(s) of the animals are difficult to see in the circumstances. Probably Dark or dark-wh. The animals also seem to be very shy. Disappear almost instantaneously, probably going out into deeper water. Without diving. Possibly without palping.

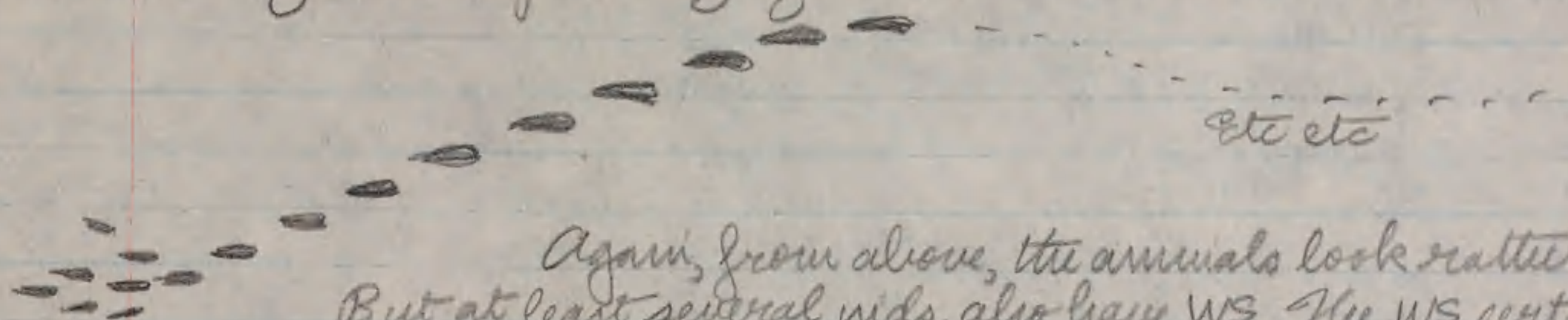
NOTE: a little farther out from shore, there are many clumps of coral scattered on sand. This looks like good courting, fast breeding, habitat

I swim back and forth along shore. 3:20. Back to area where squid were seen, from breakwater, earlier. Now there are 6-7 very large, apparently new, blobs of ink in water. Something is really scaring these animals. Is it me?

NOTE: the fish don't seem to be at all frightened of me.

Out of water 3:25. Walk up and down shore for a while.

4:00 pm. See squid in "usual" place. Large group of approximately 30 or more individuals. But this not the same group seen in the same place earlier. The animals here now range from medium to small, perhaps very small. Mostly in line, graded by size. Smallest inds. in a cluster at end.



Etc etc

Again, from above, the animals look rather dark. But at least several inds. also have WS. The WS certainly reveals or emphasizes iridocytes in some circumstances. Even once in a while a WS "flashes" when an animal moves. This looks more like a mirror-like reflection of sun light than like a real expansion of white area.

Go back into water 4:10 pm. Again swim around without being able to find squid. Presumably they have retreated (like previous group). But at least this time without inkling.

The squid here seem to be shy-er than the animals at Guam as well as the sepioidea of Panama.

NOTE: Pencil cephalopods are trapped or fished here. But they certainly are (also) eaten on Guam.

4:32. Finally see a single squid. Small (but not "larval"). This ind. is floating under a school of rather large (larger than the squid itself) "sardines". 2 ft up in 5 ft of water over sand and coral. Generally rather pale pinkish or sandy in color (paler than bottom "background"). Little or no WS. Retreats and disappears. Fairly rapidly but not in panic. Iridocytes catch light as it moves. General effect is golden pink.

This ind. certainly looked like a sepioidea at a distance. But I could not see fin shape very clearly. Could there be more than one species of inshore squid here?

Finally get out of water 4:50 pm.

ADDITION and COMMENT. It is interesting and perhaps significant that I have not yet seen any streak patterns by Lusomana (apart from Fin Stripe and perhaps belly streak with Belly Bar). This could be correlated with

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the absence of TG. But *Streakis* obviously could be useful anyhow. There is a common small fish here, perhaps a kind of needle fish (long body and elongated snout), with a long dark streak on sides of light body, which spends much of its time floating or swimming vertically, head down. Over plants as well as coral, rock, and/or sand. Single or in small groups.

Palau,
March 18, 1979.

Go bird watching in morning

When I pass along breakwater ca 6:00 a.m., I do not see any squid.

On my return at 7:40, however, there is a group of 21 or 22 Sepiots around. Near surface in approx. 8 ft water (tide is high now). Inds. range from rather small to rather large. When I first see them, they are all in Ord +. Definite WS, Y (looking really golden now, from this point of view), Spade (not Bulge), PCA (no POA). Color of Ord looks rather warm brown from here (rather very yellow nor very gray). At this point, the animals look essentially identical to *sepioides*. There is one possible or probable difference. The "mottling" (light spots) on the backs of these animals does seem to be more regular, at least more conspicuous, than is usually true of the Panamanian form.

The animals are more or less in line, graded by size, but they are not particularly close together. Group seems to be beginning to subside.

Suddenly the smaller inds., nearest me, begin to retreat. Not very fast and only a few inches. At same time, they lose their WS's. Some may also go darker, briefly. Then they all relax. Float as before. In Ord + but still without WS.

The largest inds. in the group do not retreat. And they keep their WS throughout.

After some minutes, WS begins to reappear on some or all of the smalls.

The animation between either dark and/or light and alarm certainly seems to be complicated!

Suddenly at least 2 of the medium sized inds., both in center group, but not nearest neighbors, show a conspicuous color change. Turn bright tawny golden all over (arms, head, body, fins). I shall call this "Full Gold." It is maintained for several seconds before the performing animal returns to Ord +. Both inds. do Full Gold several times. But never simultaneously. I can't tell what provokes these performances. Nor do they seem to lead to anything. The other animals seem to ignore them.

Then the whole group swims away fairly rapidly, all animals going backward, without any apparent color change at all! I leave too.

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Back to water's edge 9:05 a.m. Water is high now. (Tide here must be appreciable. Much greater than on Caribbean coast of Panama. Or in Guam for that matter.)

Find group of Sepiots immediately. Includes moderately large to moderately small inds. All apparently in "medium" Ord+.

Suddenly one of the larger inds., in line with neighbors on either side, does Lateral Flip. Quite extreme. Apparently like sepioides. Goes back to Ord+ then does Lateral Flip again. Then back to Ord+ again.

These squids then drift away, out into deeper water, before I go in myself at 9:12.

But then I find what is probably same group almost immediately. 18+ inds. 2-3 ft up in 10-12 ft water over white sand and mixed bottom. In a very milky light, sandy (or sandy pink) version of Ord+. Swimming around quite rapidly. Apparently nervous. Disappear.

I swim along Breakwater and then back. Lots of fish. Larger types very placid. Smaller minnows, on the other hand, tightly packed.

9:35 a.m. Find very large group of Sepiots. Including at least 20 rather small inds and 6+ large ones 1-2 ft up over sand and weed. All in milky light sandy coloration. Probably the same as the "version" of Ord+ cited above. But I notice that the "mottling" of the back is really composed of numerous thin, more or less "zigzag" dark bars or transverse stripes. Like the dark markings of some PH's of sepioides. The general effect is different from the usual PH of sepioides (only) because tone is different. Not really at all yellow.

NOTE: this pattern is quite cryptic in the circumstances because the water is also milky. Visibility is not particularly good.

These animals swim rapidly under me and then disappear.

I get out of water 9:46 a.m.

COMMENT: The "Ord" and related patterns of lissomiana may not be more variable than those of sepioides in the sense of reaching greater extremes, but they do seem to be more frequently or continuously changing.

Territorial arrangements by the breakwater are still not clear. Obviously complicated. Either the same area is rented by several different groups. Or (perhaps more probably?) all the various schools seen are members of the same, very large, "super group". Or the various groupings are purely ephemeral or transient.

Go out to look (from land) again later in the morning.

11:12 a.m. See very large group. Including 12-15 smalls and many other medium and large inds. The smalls are gathered in a globular cluster. The others stretch out in a line from the cluster. Line at least 20 ft long.

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Is this clustering of young typical? (A substitute for TB?)

All the inds. are more or less Dark. At least 1 large has definite WS in Dark. Everyone seems relaxed. Paying no attention to *Jelium*. Presumably basking (sun is bright now).

Go back to water 12:10 p.m. Squid apparently gone. Start to swim

12:34. Find group of approximately 10 large Sepiots. 2 ft up in 10 ft of water over sand. Visibility is bad now. But the animals seem to be in something like Ord+. As usual they disappear promptly.

I continue swimming until 12:45 without seeing anything more.

Back to water's edge 3:00 p.m. See squid in usual area. At least 10-12 large inds. More or less Dark.

Go into water 3:05. Squid seem to have gone. But then, 3:12, find a group of larges, probably same group seen a few minutes earlier. Now the animals are in milky light sandy coloration again. (I shall call this pattern "MLS".) Some Y. Probably also some PCA, but this is hardly noticeable against the general pattern. The animals pass by me fairly rapidly.

I think that MLS must be anti-predator. Cryptic. (Perhaps a partial substitute for streaks???)

I continue to swim. Out over coral. See a very large Barracuda type. This may help to explain why the local squid are so nervous.

Out of water 3:35 p.m.

Palau,
March 19, 1979.

7:20 a.m. Walking along breakwater. Water calm. Find large group of Sepiots. Near surface 31+ larges, at least 12-15 mediums.

All in more or less dark grayish Ord. With Spade. But no PCA. Some with occasional, slight, transient, WS. Perhaps occasional trace WML. Again notice that white spots on back in Ord are relatively conspicuous.

One large consistently has Y (golden), RL (definite), and WT (like *sepioidia*) in Dark-Ord or Dark.

Most of the inds. tend to get darker during next few minutes.

Several different larges go brief Full Golden. One Full Golden is accompanied by brilliant broad WS. I can't see what provokes this. Nor does it seem to induce any marked response. Sometimes followed by brief exaggerated Dark all over (for contrast). It is my impression, however, that the Full Golden could well be agonistic, probably threat. Perhaps a reaction to a too-close but non-sexual approach by neighbor. It does not seem to be connected with

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"courtship" SEE BELOW. Nor is it, I think, usually (or even?) performed by the inds. involved in courtship.

Whatever it is, this Full Golden, like the "inconstancy" of the WS, would seem to be a distinctive feature of Lessoniana.

Several other inds. show brief traces of Y in Dark.

Then suddenly one ind. shows distinct Bilateral or Double Silver.

Body turns more or less silver, white on both sides of median dark line. Commence

~~remains~~ Fins remain semi-clear. Silvery patches are not entirely "pure".
Traces of darker mottling (probably "PH" marks) remains. Mottling strongest on sides, near fins. D.E. silver, white is most intense on either side of median dark or black line. Again contrast.

See this again several more times. By several inds.

Then I realize that the whole situation here is very complicated indeed. I am seeing elaborate interactions, of two rather different kinds, in two different sub-groups within the larger group. I shall call these sub-groups "A" and "B".

A. This sub-group is centered on the individual in Dark or Dark-Ord with Y, RL, and WT cited above. This particular individual is very large, perhaps the largest in the whole entire group. Always near center of entire group. Remains in Dark or Dark-Ord, with Y, RL, and WT throughout. But now I notice that it is doing other things as well.

It always has a sort of spread. Trident effect. With WT at tip of each of the 3 "prongs".



A variable amount of WS.

Always some light speckling or spotting on dark back. Spotting sometimes conspicuous

And it also shows BB. Sometimes very strong. At other times fainter. Quite like the corresponding pattern of sepioidea in appearance

This animal swims around within a relatively small area. Usually going backward. Movements not usually very fast.

It seems to have picked up 2 associates. These also are fairly large, but definitely smaller than the animal ("A Prime") with which they are associating. Definitely a "trio". As usual one of the associates sticks closer to A Prime than does the other.

This, in itself, is reminiscent of the courtship of sepioidea

The 2 companions are sometimes in more or less plain Dark Ord. More often, they (and especially the closest or dominant associate) show some of the same patt-

ern(s) as A Prime, but in a less extreme form. Generally Dark with some WS and light spotting. Some traces of spread, but usually not very wide and with less conspicuous WT. Only small RL. And apparently, as far as I noticed, no BB at all.

The 2 companions follow A Prime. Also usually moving backward. Closest follower usually only inches behind A Prime. Second follower further back, and often to one side.

It was my impression that the same inds. played the "follower roles" throughout. Certainly A Prime was always the same individual.

Even once in a while, A Prime would swim backward at an accelerated rate. Without color change. And without any exaggerated "Fluttering" of fins. The closest associate, or both associates, would also accelerate at the same time. Also without conspicuous color change. Sometimes the associate(s) get(s) closer to A Prime in the course of the acceleration.

Usually not much happens. A Prime usually stops acceleration after a few ft. And either goes off at angle, still backward, at more or less normal un-accelerated speed. Or stops, reverses itself, and goes forward a little at normal or even slow speed. Companion(s) follow, at equally reduced speed. Nothing very much in the way of color changes at any time.

Once, at the end of an acceleration, the close companion rose above A Prime, drew more or less level with it, and then turned over on its back and struck downward, with one or more arms (or tentacles) at general area of A Prime's head or opening of mantle. This looked very like a copulation attempt. But I cannot be sure about this. A Prime did not react visibly. The belly of the companion was more or less clear. Fairly light "neutral" in color. It flipped right side up almost immediately. And color of upper surface seemed to be just as before.

Another time, some minutes later, when A Prime was going forward after a backward acceleration, a following companion accelerated forward, caught up with A Prime from below and struck upward and forward. I don't think that the companion was ideally placed. Its strike may well have hit A Prime in the belly rather than at mantle opening or head-arm mass.

In any case, A Prime never showed arm movements as if it were arranging a spermatophore.

NOTE: Some of the backward and forward movements of the animals of the A subgroup were slightly reminiscent of the Rocking of sepioides. But less regular and much less frequently repeated. Probably also without any very great rises and falls.

COMMENT: What was this all about? The whole interaction certainly looked sexual, at least in some ways. But it also reminded me of some Z-spread encounters of sepioides. Without, of course, any trace of actual Z?

→ Strikes not very rapid

QUESTION: Does this species lack Z?

B. A sub-group of other colors!

Composed of some 6-10 inds. All large, but not quite as large as A Prime. "Clutered" at one end of the entire large group. I.E. usually 5-10 ft from A sub-group. Usually or always separated from A sub-group by 6 or more other large but placid inds. which were not interacting with either sub-group.

These B animals also seemed to be engaged in "courtship". Approximately half the members of the sub-group played "♀" roles, while the other half played "♂" roles. As far as I know, there was no exchange of roles. But I might easily have missed any exchange if it was rapid and/or inconspicuous.

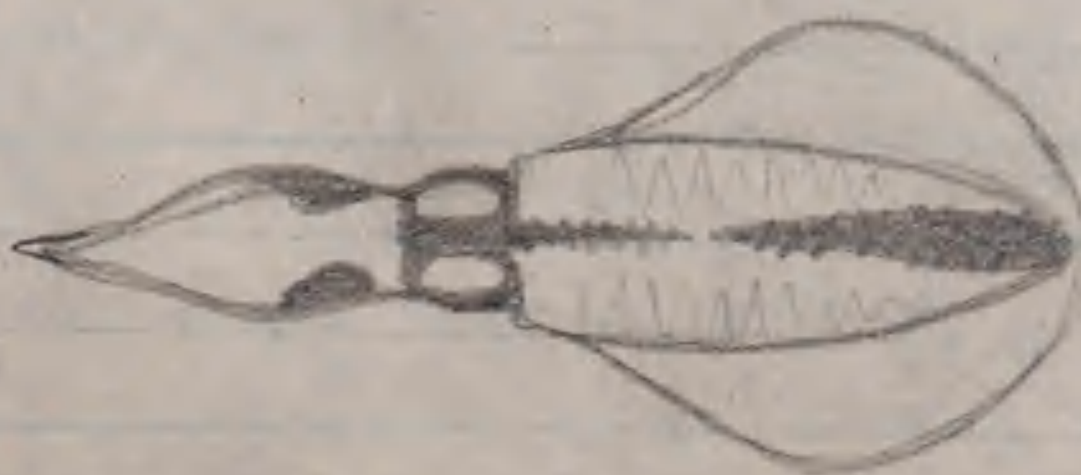
Most of the time the animals were swimming rather placidly, in the coloration that was "normal" for the whole group, i.e. Dark-Ord with few or no "accents".

Every once in a while, one ind., a presumed ♂, would make a forward pass at another ind., presumably ♀. It would change color, going more or less tawny yellow all over, with at least some trace of (yellowish) WS, probably Y, and at least a trace of faint PH-type darker markings. Then it would swim rapidly forward toward "♀". Usually to one side of "♀". Perhaps also sometimes underneath. Probably some indications of Bending during some approaches. And certainly some occasional spreading of arms (and tentacles?) More general and/or irregular than neat trident-shaped no flutter. Perhaps like "writhing" of sepioides???



This tawny yellow coloration recalls the "Yellow" and "Yellow PH" of sepioides. It may also be functionally equivalent to (at least partly homologous with?) the Partel.

The "♀" always, while I watched, responded negatively to approaches of this kind. Always retreated. Either forward or backward. Very occasionally with Lateral Silver. (Light side toward approaching "♂"?) Usually with Bilateral or Double Silver. It is obvious, in fact, that this Bilateral or Double Silver is strictly homologous with the Pied of sepioides. I will call it by the same name, for convenience. But I must remember that the form is slightly different.



Trail RL???

Generally very bright silver. "Mottling" on sides. Median streak black. Sometimes interrupted in middle. Faintest toward rear. Top of head dark except for 2 blackish patches (true Bar II) on either side not far from base of arm mass. Quite stereotyped.

The retreats usually are brief and short. "♂"s usually drop back and resume Ord or Dark Ord as soon as a "♀" signals her unwillingness.

I did not see any "♂" ever strike at a "♀". But I did, several times, see "♀"s make fumbling or re-arranging type movements with arms as if spermatophores had been placed on their foreheads. (This could also, I suppose, have been some sort of DF-type display.)

Once a "♂" made a pass at a "♀"s. Both "♀"s retreated in Pic.

More often only a single "♀" was approached at any one time. But (there also) there were occasional hints of trios. 2 presumed ♂s following 1 presumed ♀. 1 ♂ appearing to be dominant over the other.

Once a "♂", after a pass, shot backward, still in tawny yellow, after an approach. Panned closely, other inds. Showed single, unilateral, DM at base fin on side of nearest neighbor.

COMMENT: All this is very difficult to interpret. Both A and B subgroups looked like they were engaged in "courtship". But their "courtship" took very different forms (at the same times, and within a few ft. of one another). Why? Did I completely miss the point? Or were the A's and B's at different stages of the reproductive cycle? (Perhaps the A's were just beginning courtship, while the "♀" B's had already received their spermatophores some time ago???)

Is it conceivable that there is more than one type (species) of Sepiot in this region????

MISCELLANEOUS OTHER POINTS:

While all this was going on, I saw one large ind. apparently engaged in fishing of very small minnows. Advancing on them in Dark, with tentacles partly extended and conspicuous WT. Apparently successful in catching one. Falls back, still in Dark but now without WT.

Several times, in the course of this morning's observations, I see the whole group of Sepiots retreat before an oncoming fish. These retreats also brief and short. Once the alarming stimulus was a pipefish. Another time, it was an Abudofduf-type. The third time, the stimulus was unseen (but it caused minnows to jump out of water some yds away). In each case, the Sepiots came close together and swam away in a medium-color or semi-light "Ord +", with WS etc. This pattern must be slight alarm. But it looks like "relaxed" or "normal" pattern of sepioides. Have the sepioides been more nervous than we thought? Or is this just a threshold difference between species?

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It seems to be a general rule that WS's are usually more extensive, wider, toward the rear than toward the front of the back.

COMMENT: It is interesting that the WS and the Pie (black median streak) are almost exact reversals of one another, even though they both seem to include escape components. Only the contrast between dark and light seems to be similar in both.

Stop observations 8:10 a.m.

Back at Sea Wall 2:58 p.m. Tide is very low. Water surface very rippled. See group Sepiots in line, but very far apart from one another. Near bottom.

Mostly in Dark-Ord+. Several with conspicuous WS.

Group includes at least 15 Larges, plus a smaller number of mediums.

"Cowstrip" seems to have stopped for the moment.

Palau,
March 20, 1979.

Going to watch at seawall again this morning. Arrive 6:30 a.m. Water is low and smooth.

Find group Sepiots immediately. 17 inds. 2 fairly large, ranging down to fairly small medium. High in water over mixed bottom. All in medium Ord. Most with definite WS. Some with Y. Little or no PCA or Spade.

Then all retreat out of sight. Apparently without color change as they go. But they are back again almost immediately.

I suppose that larger group is just assembling.

Several more Larges appear. 3 together. One does spread or Flare in flash of Jawm.

Some of the mediums are making feeding type advances without color changes. Catching small crustaceans.

One large retreats backward before another advancing forward. Retreat ing ind. in semi-Pie. Advancer in Ord+. Then advancer turns back.

One semi-large advances, without color change. Apparently catches small prey right in front of a larger ind. The latter flares briefly, but that is all. These flares or brief spreads presumably are hostile (and aggressive?)

2 Larges swimming together. One Pies. Then relaxes.

Several inds. in semi-Dark without WS now 6:50

2 mediums swimming side by side very close together. One suddenly goes Full Golden, no WS, for a second. Then immediately, very Dark, also for a second. Then relaxes into Ord+.

Possibly Full Golden is less aggressive than Flare?

There are now 21 inds. in group. 4 Larges at one end of line, a fifth

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Large at other end, smaller inds. in between.

The "isolated" fifth large seems to have caught small fish. Then advances toward school of fish again. In Ord with conspicuous Y, WS, and white spots on back. Tentacles semi-extended with conspicuous WT. But it does not shoot. Eventually retreats in same color without WT.

This kind of WT certainly is a feeding pattern.

Another ind. briefly Pales after catching small prey (fish?).

17:00 Suddenly all the animals retreat backward a few ft. Only go very slightly paler as they do so.

Suddenly one large goes yellowish, indication of Tawny and/or Full Golden, with conspicuous WS on rear part of body, and 2 conspicuous DM spots, on either side of body (flanking WS), when a slightly smaller ind. approaches. The latter immediately retreats a few inches. I.E. threat is effective. The approached animal then resumes Ord.

The whole incident is repeated a few seconds later.

Several more brief retreats with no color change or only slight paling (presumably to "milky" tone).

One large swims forward to another. Approacher is in semi-Pic, with conspicuous Y, and definite BB. This BB is different from the one shown by A Prime yesterday. It is a thin black line. A Prime's was broader, gradually fading out toward body (as in drawing made yesterday). It is possible that the BB of the animal today also has thin white line just outside black line for a few seconds. A kind of WB. But this white disappears almost immediately. The approached animal retreats in semi-Pic. Then both relax 17:13.

Group still composed of 21 inds. Still distributed as before. All gradually drifting along sea wall. Very placid on the whole. Very different from yesterday?

One large "flashes" WS when Abrudofus comes close. Again.

Feeding seems to have stopped for the time being.

17:22, There are now 22 inds in group.

Whole group retreats briefly, without color change, when large school (20+ inds.) of pupifolius comes swimming along bottom.

The 3 smallest inds. in the group (really quite small, although certainly not "larval") are swimming close together. Suddenly all 3 suddenly turn more or less Tawny and swim rapidly backward a few inches. 2 have Y. One of the inds. with Y also shows brief DM, 2 spots on body. What provoked this?

Then the 3 smalls scatter. One goes on to catch small prey. Definite strikes. Tentacles protruded beforehand. But no WT. Body still generally Tawny.

It is very difficult to tell the difference between low intensity versions of Tawny and of Full Gold. If, in fact, there is a difference.

Ceph, Mar 20, 79, III

(23)

Everything still very dull 7:40. Have the inds which were "courtship" yesterday gone somewhere else (riffs) to continue (and finish) their courtship. Group is down to 21 inds. again.

NOTE: In Dark fins are usually semi-dark while still semi-transparent.

Group is now rather jumbled. And no longer graded by size.

One large approaches school of rather large murex, in rather pale, conspicuously spotted Ord, with WS and L, tentacles protruding. Retreats in same color. Then advances again. In same color, but this time also with WT and (briefly) White Fins. Then retreats without WT or White Fin.

Squid suddenly gone 7:52 a.m. Of course, while I am writing my notes! Stopping observations 8:00 a.m.

March 22, 1979
Guam.

We couldn't go out yesterday because of heavy winds. But the weather is much better today. We will try several sites on the west coast. More or less to the north.

10:15 a.m. Gun Beach. There is a cable channel here. Corner and Moore did their work on *Sepia latimanus* here in relatively deep water, while individuals of *Sepioteuthis sepioidea* have been seen (only last week) in shallower water here. The bottom is gently sloping coral. The water is clear today.

We all (4 of us) swim around until 10:30, without seeing a sign of either cuttlefishes or squids!

So we go on to Dos Amantes Point, a little bit further north. Into water 11:05 a.m. The environment looks much the same as at Gun Beach. But we find *Sepioteuthis* immediately.

At least 3 large and 2 medium. All are 1 ft, or less, down in 15 ft of water over coral, 20-30 ft from shore.

The animals are not doing anything very spectacular, but they are still surprising. They are remarkably scattered. Usually at least 10-15 ft apart from one another. Sometimes much more.

They all seem to be feeding. Floating perfectly normally. Then making diagonal upward, forward "approaches" with arms and tentacles partly extended. Then stopping, backing off, pausing. Then resuming approaches. Etc. Etc.

They do not make conspicuous stunts with tentacles as a climax to their approaches. But I think that they are catching very small prey (invisible to me) with their (other) arms. This area is known to be thick with very small

larval fishes as well as with small crustaceans.

The rising approaches bring the squid very close to the surface. Probably within 1 or 2 inches in many cases. This is the highest that I have ever seen Sepiots (except when being pursued by large predators). These squid apparently do not fear attacks by birds from above. Which is surprising. Particularly as the cliffs of Dos Amantes are breeding sites for both Brown Noddies and White-tailed Tropic birds. And both species of birds are flying around today. (We also see a Brown Booby nearby a few minutes later.)

Panamanian Sepiots certainly seem to be more wary of predatory birds. Why? Is it because the Brown Pelican occurs in Panama? There are no pelicans in the SW Pacific.

All the squids here today show essentially the same color pattern all the time. A sort of Ord +.

Basic color of Ord is more or less grayish (brown) on back. With well defined WS. Usually white spots on back also fairly conspicuous. So is WML. (This shows up particularly well in front view. It often appears to be blue-ish white. Reflection). There is also PCA. But not, apparently, Spade. Belly is quite clear, light (but not glittering white).

Rather surprisingly, there is no Y. Not even when I approach very closely (2 ft). Does this mean that the Y of lesoniana is less of an alarm pattern than the corresponding pattern of sepioides? (Viz also the A. Prume individual watched a few days ago.)

The Ord + also includes other components. Several features are conspicuous in side view. There is a dark "bar" on side of head, behind eye. This contrasts with both the light color of the eye and with the WML immediately behind. There is also a peculiar bluish-purple, semi-iridescent, "bloom" along side of body, especially toward the front. This bloom seems to extend onto adjacent parts of fins. This bloom is really quite conspicuous in this light. I can't tell if it is intralysed per se or not. (It may well have been present in many other inds. that I observed on other occasions. I might have overlooked it when observational conditions were less favorable.)

At least 2 of the larger showed them sharp BB's on their fins when I approached them closely. The black lines were really too thin to be observed at any distance. So I can't be sure that they were present in all inds. at all times.

Get out of water 11:30 a.m. Go still farther north. To channel by San gusson Power Plant. Again the environment is coral bottom. Lots of medium sized fishes. But no squid. Stop 12:20 p.m.

COMMENT: the local people here keep saying that they encounter squids in channels. This probably reflects the concentration of swimmers as much as the

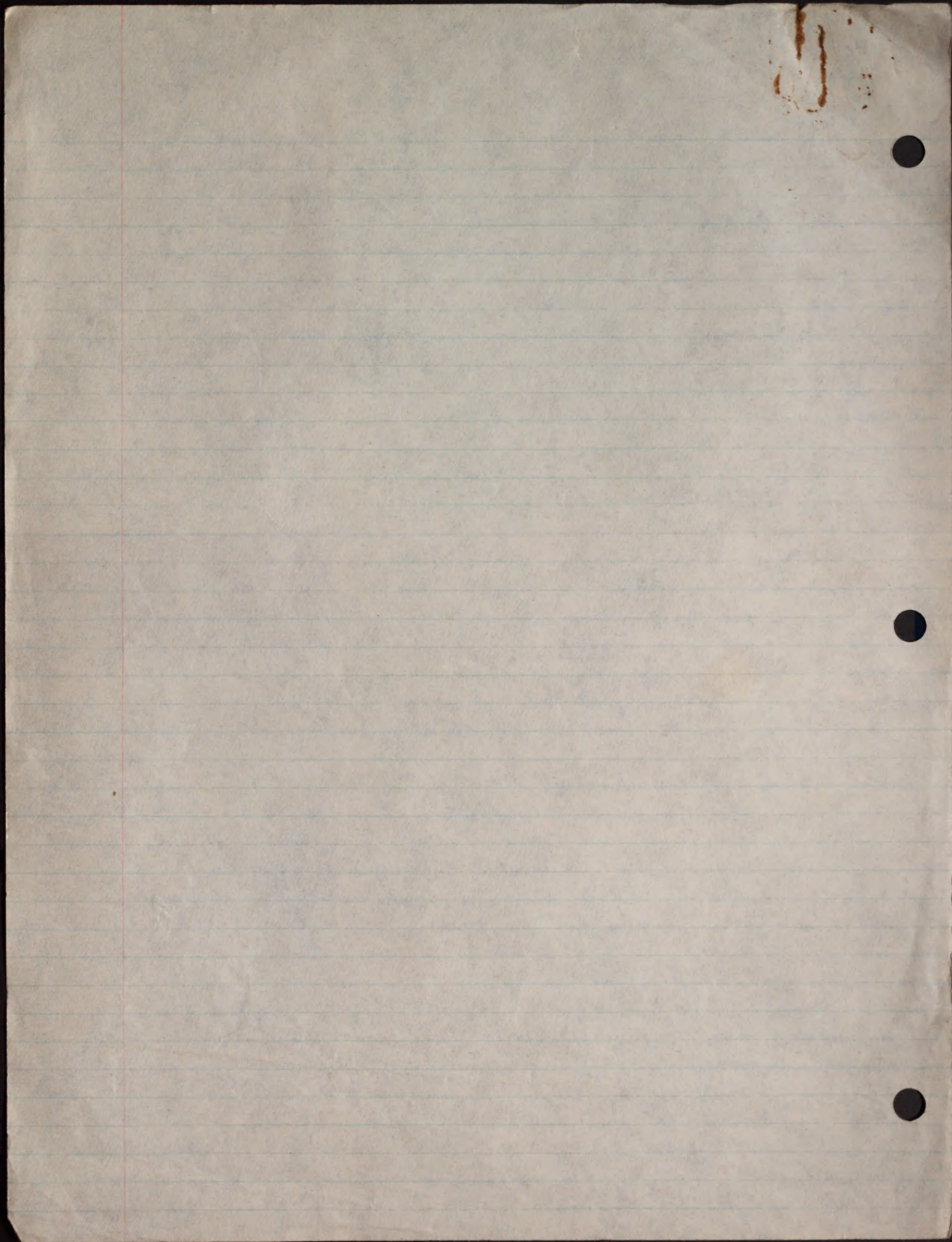
Ceph., Mar. 22, 79, III.

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preference of the squids.

ADDITION: I gave an informal seminar at the lab yesterday. I asked if anyone had ever seen any large concentrations of young Lepidoteuthis anywhere on Guam. The answer is no.

Someone did say, however, that there is lots of Thalassidroma on Palau. I wish that I had known it at the time! It might help to explain why Lepidoteuthis are more common on Palau than on Guam. If this is indeed the case.



CephalopodaGuam,
June 28, 1981

SEE ARCADIO'S NOTES

Work around Sepungau Beach area 10:50 am - 12:55 pm.

Great variety of environments, sand, coral, etc. Looks ideal, but only one encounter with squids, 11:23. Obviously Sepioteuthis. Presumably Lessoniana. Group of 3 inds. To me, they looked like 2 mediums and 1 small. But A, who was closer, says that the largest 2 were actually large by our definition of the term. (A also says that the largest Lessoniana are considerably larger than any sepioides.) The 3 inds. were in mid-water in 8 ft. over coral. All in rather grayish Ord. Plus WS, WML (conspicuous), and PCA. The inds. drift off immediately. Without noticeable color changes.

Guam,
June 29, 1981.

We did not go into the field today.

NOTE: Berkeland just came back from Palau a few days ago. He saw large groups of squids by the Mariculture Center. He also saw one cuttlefish. Also in shallow water by the breakwater of the Center. But never in association with the squids. This ind. was seen on several successive days.

Guam,
June 30, 1981.

Went out to the Glass Breakwater this morning. Weather mixed sun and cloud; some appreciable wind.

A starts tow from tip of point along outer edge 7:40 am. Finds large group of Sepioteuthis almost immediately. 14-15 large inds. In 15 ft of water over sand and large boulder bottom; perhaps 10-15 ft. from main mass or wall of breakwater. I go into water, but the animals disappear immediately. Presumably all these animals were in some kind of Ord.

Perhaps frightened of Dolphins

Ceph., June 30, 1981, II.

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A resumes tow 9:35 a.m. Back to tip and start along outside again. (NOTE: This part of breakwater is relatively new. According to Agge, it was built in 1978. I.E. it is not - at least at this site - an "old" habitat.)

10:10 a.m. A finds large group of Sepiots. Inds. range from large to medium. I go into water again.

NOTE: Throughout the following long series of complex interactions, I was concentrating on ritualized patterns, color changes, and special movements. It is A who followed interactions and sequences among animals. SAN. My notes are merely supplementary to his account.

When I first see group, the animals are mid-way up in ca. 20 ft of water over boulder bottom. (Again) quite close to breakwater. All inds. in (more or less) Gray Ord with WS and PCA. Perhaps Spade in some cases. They all retreat quite rapidly. Without conspicuous color changes. But they do rise very high in water - almost to surface - during retreat.

It is quite obvious that the local Sepiots are not very frightened of predatory birds. (Although I should mention that there are Brown Boobies around - in addition to noddies and tropic-birds.)

Then things become complicated and confused (at least for me).

I look back from my scribbling to see 3 inds. all large, engaged in peculiar maneuvers. At the time, I thought it was feeding. But now I think that the actions were connected with copulation - presumably the first copulation cited in A's notes - perhaps combined with some feeding distraction toward the end. Three individuals "Rocking". Again I notice that the "Rocking" of this species is much less exaggerated than is that of sepioides. Inds are usually spaced 2 together and 1 slightly apart. A sort of "two" (not necessarily the same as the two of sepioides). One ind. (which?) then advances forward in E+DF in "Pastel" coloration (light blue-pink). Advance carries it away from its companions. Then same ind. continues forward. "Points" diagonally forward. Accelerates. All this looks very much like an attack upon "copepods" by a sepioides. Then the same ind. retreats. Performs several bouts of "writhing". Could it be re-arranging spermatophores?

10:23. Inds. apparently relaxed in Gray Ord+. Then retreat again.

without conspicuous color change.

I notice, close up, that all these Gray Ords have conspicuous fine, irregular white barring.

I think that I also saw occasional White Fins.

A sees another copulation.

The courting individuals - if such they are - are only slightly separated from the other, non-courting, members of the group.

Then the courting inds. become slightly more widely separated from their companions. Perhaps "driven" by us? Now we see that there are really two pairs, Slight Rocking. In one pair, first one ind. and then the other turn "tawny" or "yellow Ord". The animals of the other pair probably do the same, more or less simultaneously.

Suddenly the members of this last pair move forward. One above the other, 1-2 ft. apart. Lower ind. suddenly accelerates and strikes upward. Apparent copulation!

10:31. All inds. except one have disappeared from my view. The remaining ind., large, is in Gray Ord +. With WS. The white stripe is conspicuously blotchy. (I should mention that the gray of the Gray Ord of this and other inds. is often conspicuously dark toward the rear, on either side of the WS. The effect is almost DM-like when viewed from the side.)

I find one pair again. In "Gray Ord" + WS. Gray parts with conspicuous "Purple Bloom".

Then encounter smaller, non-courting, members of group. Strung out in line, but apparently not very frightened. They allow close approach. They are in Gray Ord, but apparently not Purplish. No WS (definite). One - but only one - ind. has conspicuous WML. Most of the inds. are clear light below. One (not the ind. with WML) is partly darkish (Gray Ord?) on front part of sides below fins.

Then whole group retreats.

One ind - rather large - near us assumes "Pastel" during retreat. I think that what we have been calling "Pastel" in this species must be the strict analogue - even homologue - of the "Pale" of sepioides.

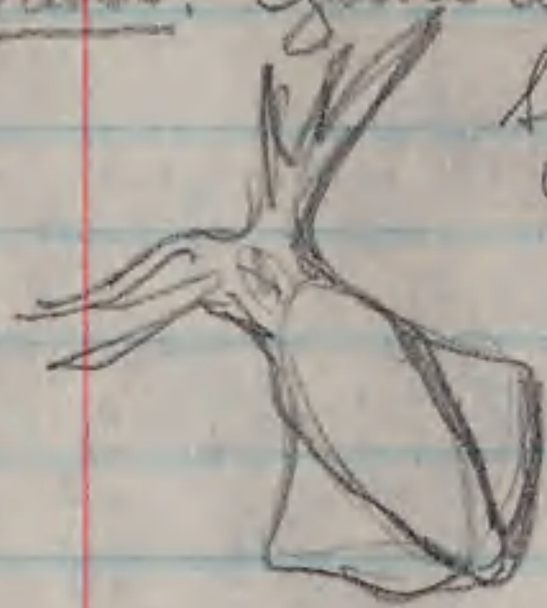
Then all hell breaks loose. A finds a ♀ laying eggs. She is accomp

Ceph., June 30, 1981, IV.

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armed by a "covering" or protecting ♂. This pair immediately becomes involved in a furious dispute with one or both members of an adjacent pair. 10:43 a.m. Dispute is rapid and violent. Details very difficult to follow.

One or two of the inds. involved in the dispute show(s) extreme Spread. Quite as exaggerated as anything by sepioides. But this extreme Spread definitely is not accompanied by Z. A different pattern instead. Dark back. Extreme WS. Dark fins. (Perhaps separated from dark of back by light on upper sides?) Arms dark with conspicuously white, or silver, blotchy borders.



There may also have been Lateral flutters (or Peds? or Bilateral flutters?) by one or more inds. at some stages of the dispute. All these "flashes" were brief.

A follows the egg-laying in detail.

In this pair - again - the ♂ is slightly larger than the ♀. Both inds. are in Pastel. Little, faint, yellow or tawny tone. Both inds. also often show what A calls "Midriff Bar". One rather broad Bar around middle of body. Not often very dark, but usually darker on back than on belly. This pattern obviously is related to the "full" Bar pattern of other cephalopods (presumably no. 4 from the front?)

Once Midriff of ♂ develops into 3-Bar on body, above and below. Perhaps as a reaction to us.

♂ also assumes E's rather frequently. In both "Pastel" and Midriff, I think.

♀ makes repeated descents, at irregular intervals of a few minutes, to presumed nest site. The ♂ remains hovering above while she is down. Nest site seems to be in or under boulder. Perhaps 4 ft down in 8 ft water ??? (Check A) And apparently there is a small ♂ Pomacentrid near by!!!

Both inds. assume 3 or 6 Bar pattern when I drift too close. Go back to Midriff when I swim away.

Midriff is often accompanied by Head Bar.

Then I see one full Bar. According to my notes, with 6 Bars. But this must be checked and confirmed.

Ceph., June 30, 1981, V.

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NOTE: When Midriff is particularly dark on back (and light on belly), it looks rather like a dark "dorsal shield". Surely this is reminiscent of some other cephalopods? Cuttlefishes?

The ♂, at least, often has "Y" — again silver — in various patterns and much or most of the time.

11:10. ♂ is doing fewer E's now. But Midriffs and semi-Partits are still common.

NOTE: There are a great variety, and considerable numbers, of rather large fishes, in this area.

Activity seems to be decreasing 11:07 a.m. And the animals start to drift away and apart from one another.

I get out of water 11:13 a.m. A continues. He is joined by Aggie. The Sepiots come back. A sees a lot of stuff, including more copulation(s), disputes, and egg-laying.

COMMENTS:

(1) The Bar patterns of this species would appear to be strongly hostile. And they certainly are not cryptic (perhaps not even very disruptive) in this environment.

(2) There is no doubt that Streak patterns are at least rare in this species. Why? Just the absence of Thalassia?

(3) The various ritualized components in the repertoires of Lessonia and are are generally comparable to the corresponding patterns of sepioidea. But there are numerous differences in detail. And some striking contrasts.

(4) More important, however, is that they are used in rather different ways. There is evidence — the relatively simple nature of precopulatory sequences, and the close protection given to egg-laying ♀'s by their accompanying ♂'s — that pair bonds are stronger and/or longer sustained among the local Lessoniana than among the sepioidea of the San Blas. Why? Is predation (presumably from fishes) stronger here than in Panama? Because deep water is so close here?

The fact that the local Sepiots are so often skittish here may be another indication of the severity of predation.

Ceph., June 30, 1981, VI.

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NOTE: The non-breeding animals seen today may have been less skittish than usual because they saw that the breeding adults did not leave the area on our approach.

Guam,
July 1, 1981.

Again going to work along outside face of Glass Breakwater.

A begins tow from tip 9:23 a.m. Mixed cloud and sun, but wind seems to be less strong than yesterday.

9:30. A finds group of 20+ Sepiots. Many larges (perhaps grading down to medium ???) When I get into the water, I find them in a diagonal line. All in Gray Ord. One ind. seems to have RL (but this could have been a scar). Another ind. shows WT.

Then suddenly one ind. goes "Pastel" with Fin Stripe. It approaches one or more other inds., back ward, 3-4 times. The approached ind(s) retreat(s). Without conspicuous color changes. Approacher stops each time approached retreats. Does "flare" (arms spread three-dimensionally). At least one flare includes DF.

NOTE: We are seeing all these "Pastels" from the side. We cannot determine the appearance of the animals as they might be observed from above. It is conceivable that what I am calling "Pastel" here is related to what I called "Bilateral Silver" in Palau in 1979. But I doubt it.

All the inds. move off 9:36. A resumes tow. Sees group of 9 Sepiots, presumably large. Inactive and uninteresting. Then group of 13 larges. All gone before I can see them. NOTE: Population of large Sepiots is dense along the outer face of this breakwater.

Then we tow back and forth along breakwater. Certainly passing and re-passing site of egg-laying yesterday. Nothing today. (This is interesting in itself.) Then A continues tow in landward direction.

10:50 a.m. A finds group of 30 rather small young. Close inshore. (NOTE: all animals seen today, including later groups - see below, were quite close inshore.)

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The occurrence of these young Sepiots so close inshore is contra an earlier hypothesis of A. He was under the impression, as a result of earlier observations, that young *Lissonoteuthis* tend to remain further offshore than do adults (mediums naturally intermediate). This may still be true as a general rule. But there must at least be exceptions.

A continues tow out along reef adjacent to breakwater. 11:08. Finds 15-18 large Sepiots over coral and sand bottom. Disappear immediately.

NOTE: sea is calmer today than yesterday. Could this help to explain difference in behavior of the animals. (ADDITION. No! Behavior is not so different after all. See below.)

We reverse direction and A tows back toward tip of breakwater. Again nothing where egg-laying occurred yesterday. But further on - in area where Sepiots seen first today - A finds some large Sepiots 11:58 a.m. Apparently a "trio". One ♂ and one ♀ (the "pair") closely associated with one another. A third ind., presumably a "secondary ♂", a little farther off.

When I first see the animals, both inds. of pair are in Gray Ord +. With WS, WML, PCA. Possibly also WB (!). Then the larger member of the pair, presumably the ♂, assumes Pastel with Fin Stripe. Goes 6 ft. down (water depth here may be approximately 8-10 ft), apparently to visit nest site. ♂ of pair comes up again, approximately at same time as secondary or accessory or intruding ♂ approaches. The latter retreats. Not much in the way of color changes by anyone. A few seconds later, all 3 inds. are back in Gray Ord +.

♂ and ♀ of pair, at least, have conspicuous Purple Bloom. Purple is strongest on sides of back.

QUESTION: Does ♂ select nest site for the ♀ - or at least indicate it to her ???

The three animals drift away. But we find them again immediately.

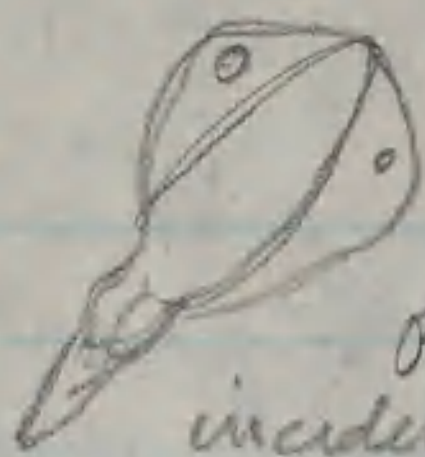
The ♂ of the pair is in Pastel. With Fin Stripe at first. Stripe disappears later. Swimming close beside ♀. His fin beats are greatly exaggerated, but he is not travelling particularly rapidly. The 2 inds. are sort of wandering about, sometimes back and forth. But, again, there is no ritualized Rocking. Exaggerated Rocking does seem to be absent in this species or population.

The ♂ of the pair has a peculiar feature (or pair of features). One white

Ceph., July 1, 1981, III.

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spot on each fin. Comme ça.
But they certainly are em-
ing. (This Fin-beating.
Some or all of the exaggerated Fin-beating may also be accompanied by some-
thing like WB.



Not equal in size. Perhaps scars
phased by the exaggerated Fin-beat
incidentally, must be a display in itself.)

The ♂ of the pair also shows occasional Flares and E's with DF.
And WT throughout (intention movement of "striking"?).

The ♀ remains in Gray Ord with WS, WML, and PCA. Her fins are
usually or always dark-ish.

Now I see that there are at least 6-7 other inds. (all large?) around.
Pair drifts off. A goes to get camera. Back. We find 2 inds. One
probably is ♂ of pair (has white spots on fins). The other may or may not be his
female. Both inds. are in Ord + \Rightarrow semi-"Pastel". Then there is a brief but
obvious dispute. I do not see the releasing stimuli. Nor can I be sure who,
exactly, was involved. In any case, dispute includes a spread by one ind.
Black blotches on arms; but certainly no typical Z. Then both disputants
swim off, away from one another, at least at first. In "Pastel", probably with
Fin stripe

One ind. (again) does exaggerated Fin-beating with white spots. Several
other inds. approach. They are in Gray Ord +. The white-spotted ind. moves
closer to them. There may be more "courtship". But I withdraw as A
photos.

12:20 pm. Pair in front of A. More or less in (gray) Ord (+). One of
the members of the pair, apparently the ♂, goes down to nest site. 3 ft down
in 4 ft of water. In blue-ish "Pastel". Followed by apparent ♀ (visibly
smaller - size dimorphism is unmistakable). She is in a browner version of
Ord (+) than is the apparent ♂.

Water is getting rougher now. A definite swell.

Both inds. go down to nest site again, and up again. Several times.
Presumed ♀ usually in lead now. In brownish Ord (+). Presumed ♂ re-
mains behind and above during descents. Occasionally shows Midriff Bar.
With Spade

Then ♂ assumes blue-ish Pastel again. Goes down alone. Up. Then both

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go down again, ♀ first ♂ still blue-ish "Pastel". ♀ still somewhat brown-ish. All over except for definite WT. Both up again. ♂ rises in usual blue-ish. ♀ still in brownish. But whole head and arm area definitely paler, more yellowish, than back during first part of ascent. (NOTE: Both animals ascend tail first.) Then both animals animals float, close (12") together. Resume Ord+.

The ♂ may have had WB in some or all of his blue-ish Pastels. Now I see that there is another "pair" (or 2 ♂'s) only a few feet away. Obviously egg-laying is often public in this species or population.

Animals drift off. Apparently gone. I come out of water 12:45 p.m. But A and Aggie remain. And the animals come back almost immediately. Behave as before, with added complications. ♂ of pair continues to go down to inspect nest site(s) alone from time to time. At which points, neighboring secondary, or accessory ♂'s rush in and attempt to copulate with the isolated ♀!!! From below. Attempts not necessarily successful. ♀ does not seem to be cooperative.

A also sees "roll over", upside down, copulation attempts among neighboring animals.

I go back into water 1:15 p.m. A still photo-ing. 2 inds in blue-ish "Pastel". Both go back to Ord+. 3rd ind. approaches. A disputes. At least one individual, and quite probably two individuals (♂ of pair and another ♂?) first assume(s) "Pastel" with Fin Stripe, then go(es) darker above while Fin Stripe disappears. At same time, one ind. shows BB, the other shows generally dark fin. Then there is a brief spread by one ind. With blotches on arms.

This sort of behavior continues. ♂ of pair ranges from "Pastel" to Ord+, always blue-er than ♀ who remains in brownish Ord+. (This brownish is not usually yellowish, or even tawny.)

Both inds. retreat before A. ♀ in brownish Ord plus Fin Stripe. ♂ in semi-"Pastel" plus Fin Stripe. Both inds. lose Fin Stripe when retreat stops.

COMMENT: The Fin Stripe of this species or population may well be something more than an "adjective" or "adverb"!

1:25 p.m. Animals drift away. We all go back to boat.

COMMENTS:

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(1) This species does seem to have fewer ritualized patterns than does sepioidea. Or, at the very least, it varies them, in rapid sequences, less frequently. The generalization may hold for both sexual and anti-predator behavior.

(2). We have seen very little feeding. Does this mean that the local animals are more nocturnal, as predators, than are sepioidea ???

ADDITION or CORRECTION. Actually, the term "nest site" as used above may be something of an oversimplification. Actually, the members of the egg-laying pair observed today (or at least the ♂) seemed to visit two slightly different spots - perhaps 1 ft apart from one another. But eggs were found at only one of the spots.

SAN.

Guam,
July 2, 1981

We did not go out for squids today.

COMMENT: It has occurred to me that many of the apparently peculiar characters of the Lessoniana of Guam may be correlated with one in a functional complex. Among these characters are:

1. Relatively great nervousness or shyness (at least apart from egg-laying sites).
2. Copulation and egg-laying (and not only preliminary courtship) occurring while the performing individuals are (still) in or near groups.
3. The ♂ is particularly assiduous in "covering" the ♀ during egg-laying.

All these might be explained on the assumption that Lessoniana is more vulnerable to predation (by marine predators) than is sepioidea.

If so, then the reason for point 1. is obvious.

Copulation and egg-laying may occur in groups because isolated pairs would be too vulnerable. Viz all the evidence that schooling is protective.

Given the advantage of continued schooling as well as the danger of predation, then it is not surprising that a ♂ has to defend his ♀ carefully and

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continuously.

It is interesting that the egg-laying site may be a natural correlate, or even consequence, of the strengthened pair bond.

So may be the apparent reduction or simplification of precopulatory display.

It is also possible that the apparent reduction of "silver" displays in general may be due to their extreme conspicuousness, only too easily noticed by predators. (Could "Z" fall into the same category?).

Perhaps the "likes" of Sepia latimanus could also be explained as adaptations to maintain gregariousness through the sexual period.

Of course, the reason why the local Lersoniana may be particularly vulnerable to predation is the proximity of deep and open water. (Bill Hammer told me today that oceanic squids are almost impossible to see during dives — presumably because they are too frightened of new stimuli.)

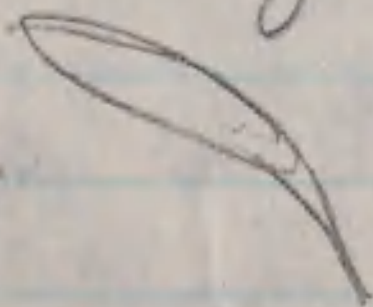
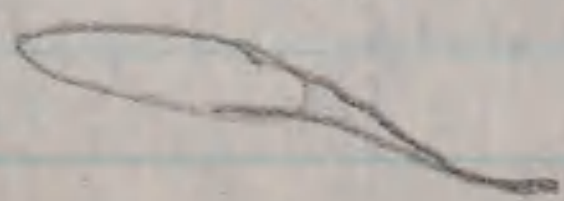
It will be interesting to observe the "Lersoniana" of Palau in their semi-protected lagoon!

Guam,
July 3, 1981

Back to Glass Breakwater. Weather much as usual. Mostly sun. Occasional rain. Wind stronger than yesterday.

A starts tow from tip 7:32 a.m. Goes past sites where egg-laying was seen 2 and 3 days ago.

7:38. Finds group of squids. 40+ Two apparent pairs of large inds. Other inds. smaller (but none very small). I go into water. The animals are near surface (again) in 6-8 ft of water over boulders. All more or less in Ord. The Ord of the 2 pairs of large is definitely "plus". There is little or no courtship within the pairs. Inds are swimming or floating in a variety of un-interesting postures. Horizontal. Slight "Downward P". Or slight



"Upward P". All these postures obviously are unritualized.

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NOTE: Among the postures apparently lacking in the local lessomana is the ritualized Upward Curl. Why?

When I first see the inds., they are rather scattered, facing in different directions. Then they close up in line — probably in reaction to us — without any conspicuous changes in color.

All this is very dull. We stop 10:10 am. A resumes tow. Goes down to reef area. Then back to tip. Once, he sees group of 7 large Sepiots. Twice, he finds groups of 50+ inds., but they are very spooky.

11:30 A starts to tow inside Breakwater. Nothing. We stop for the day 11:45

NOTE: Just in case it might eventually appear to be relevant, I should mention that New Moon was July 1st. First Quarter Moon will be July 9th. Full Moon will be July 17th. Etc.

Guam,
July 4, 1981.

Glass Breakwater again. Sunny. Less wind than yesterday.

A and C start tow from tip of Breakwater 9:29 am. A sees two large Sepiots almost immediately. But they disappear like a flash.

9:36. A finds 21 large Sepiots. In Ord + (i.e. WS, PCA, Spade). General town is neutral. Really flat gray (as seen under water). Neither very blue-ish nor very brownish. The animals are approx. 5 ft up in 8 ft of water over boulders. As always very close to the breakwater itself. When I first see them, they are strung out in line. Then they retreat. Not very panic-struck. Some inds. probably show trace of semi-"Pastel" in retreat. But definitely no Fin Stripe.

COMMENT: This sort of semi-"Pastel" must be the exact equivalent and homologue of the Pale of sepioides. It only looks "Pastel" because the iridocytes are expanded and appear to be blue when viewed through the water. Either the local lessomana have fewer leucophores than the sepioides of the San Blas. Or, more likely, they have larger and/or more numerous iridocytes. Viz the "Purple Bloom" S!

Ceph., July 4, 1981, II.

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Somehow, the large group splits up in the course of the retreat. Leaving (at least) one group of 10 inds and another of 14 inds. (Have newcomers arrived?)

We follow group of 14. When we catch up with them, at least one ind. is in a form of Ord which appears to be almost "semi-Double Streak". Dark of back is concentrated above (perhaps even darker than usual?), leaving sides of back light. This is, in this particular case, rather conspicuous because the fins are simultaneously dark all over. Several other inds, in more or less Ord, have restricted BB, just along borders of fins.



← Could this be an adumbration of the usual Spread pattern?????

One ind. advances toward sandlines. In Ord+. With definite WT. And tips of tentacles are split:



This could be more rather than ginsights.

The ind. retreats in the end without striking.

There are no signs of courtship in this group. (Although A did see a Spread. SAN).

Animals disappear 9:50 a.m. A & C resume tow.

10:06. A sees large Barracuda.

10:12. A finds "nesting pair" of Sepiots. In rather shallow water over boulders next to Breakwater. The animals visit 3 different sites, a few yards apart, in rapid succession. Obviously prospecting. Then move on.

We find pair again a few minutes later. They now (very rapidly?) have selected a definitive site. The animals are very close to Breakwater. In swell and almost in air bubbles. Difficult to see - or at least to follow. Site is perhaps 8 ft down. Perhaps less.

The actual behavior of the animals is difficult to determine in detail, but the general outline is clear.

Ceph., July 4, 1981, III.

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The ♀ makes repeated visits to hole or crevice of site. At irregular intervals (of only a few minutes). Usually stays at site approx. 10 sec. (according to C). ♂ usually follows her down, but never (as far as my observations go) actually enters the crevice or hole. He usually remains hovering a foot or so above the ♀ during her visits.

NOTE: A visits site early in our observations. Apparently no eggs at this stage. But eggs must be (being) deposited later.

Between visits to site, the ♂ and ♀ hover together half way up in water column.

The ♂ usually is in gray and/or blue Ord (+?) while hovering with or without the ♀. The ♀ has similar coloration when she hovers with ♂ in water column between visits to site. But she turns brown (and probably darker) when she goes down to site. And this color is maintained during the first part of her ascent after a visit.

Occasionally, the ♂ follows the ♀ further down than usual. When and if so, he also tends to turn brownish at his nadir, the lowest point of his descent.

These colors certainly are adaptive. Quite probably cryptic. Gray or blue Ord is difficult to see high in water column. Brown may resemble boulders low down.

Once, at least, the ♂ does exaggerated flutter (fin beat) while hovering beside ♀ relatively high in water column between visits to nest site.

Once the ♂ follows the ♀ almost to site. And he assumes full Bar while he waits outside crevice.

A starts to film 10:45 a.m. I back off.

10:55. Both inds. of pair beat a small and brief retreat. In semi-"Pastel". Probably no Fin Stripe. But the animals come back immediately and resume behavior as before.

NOTE: These animals are doing little or no Midriff Bar.

♂ assumes extreme full Bar, apparently with E, when A moves in to photo close up.

I get out of water 11:10 a.m. A continues. Shoots 3 rolls of film, and completes 1 roll of color stills. He sees a great variety of high intensity re-

Ceph., July 4, 1981, IV.

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actions. Copulations, apparent escape attempts (there are other langes in the neighborhood!), Spreads, "Gold" displays, more laying, etc. etc. etc.

SAN.

At some point in this period, C sees a skipjack attack and take another Sepiot some 20-30 ft away from pair.

We finally leave area 12:40 p.m.

Guam,
July 5, 1981.

We try Yppao beach this morning. Enter water 10:12. Sunny and windy. Bottom here is sand, rock, and coral. A has seen Sepiots here before. The area is certainly loaded with fish. But today the tide is high, the currents are strong, and there is considerable surf. We give up at 10:40.

Guam,
July 6, 1981

Going to try some night work. Glass Breakwater. Arrive tip just before sunset. Sea is rather calm.

A begins tow 6:48 p.m. Almost immediately, he sees groups of 2 large Sepiots. They disappear. Then he sees groups of 8 young Sepiots. Tow resumes.

Tow set by 6:57

A tows all the way in to reef, then part way back. No more squids seen.

Then we drift, shining light from boat. 7:25 p.m. Attract "copepods". A few fishes come in brief. But no squid.

A resumes tow, with light, 8:00 p.m. Nothing of interest. We stop 8:15.

COMMENT: The apparent absence of Sepiots here at night probably is real. The animals may well have gone out and perhaps into deeper waters. This may be when and where they do most of their feeding. (Certainly the presumed feeding attempts that we have seen during the daytime here have

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been minor - not enough to keep body and soul together.

According to Frankie at the lab, this is the area where deep water is closest to the island. The abundance of sepiots here in the daytime may be correlated with this fact.

NOTES: We have been trying to identify some of the local fishes.

① The species usually called "skipjack" here is Katsuwonus pelamis. It is a tuna.

② The halfbeak which A has seen with sepiots is the "Short-jawed Halfbeak", Melapetalion breve.

③ The goatfish with sepiots is more of a problem. It resembles the slender Goldband Goatfish, Mulloidichthys flavolineatus; but it also has a black spot on side.

These "identifications are based on:

SCHROEDER, R.E. 1980. Philippine Shore fishes of the western Sulu Sea. National Media Production Center, Manila. 246 pp.

JOSEPH, J., W. KLAWE, and P. MURPHY. 1980. Tuna and billfish. Inter-american Tropical Tuna Commission, La Jolla, California. 46 pp.

Guam,
July 4, 1981.

Back to usual Glas Breakwater this morning. Sunny. Moderate wind. A begins tow from tip 9:17 a.m.

9:23. A finds group of sepiots. Group probably is large. Seems to include at least 1 pair of larges. One of the members is bright white toward the rear of the body. This could be an exaggerated RL. It is more likely to be a scar. The members of this group keep retreating before our advances. Usually, I think, in some sort of Ord-type coloration.

I get out of water 9:38. A continues tow.

9:52. Almost exactly same place where egg-laying was seen first day (of my real field work - June 30th). A finds another (apparently) breeding pair. When I get into the water and find the animals, I find that there are

Ceph., July 7, 1981.

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3 inds. The apparent pair and an outrider. All very high in water, almost at surface, in approx. 6-8 ft of water over boulders close to shore. (This sort of habitat preference - during the day - seems to be very strong indeed!) The members of the pair are no more than 1 ft apart from one another. The outrider is perhaps 10 ft away from the pair. All 3 inds. are in more or less Ord. They drift away or retreat before us. Not rapidly. No conspicuous color changes.

NOTE: I find these animals extremely difficult to see at any distance. It is (again) my impression that the local lessomana are much more frequently (or especially) cryptic than are the sepioides of the San Blas.

A's eye (for squids) is better than mine. He is seeing something. He says that the members of the pair have already made at least one descent.

Then I see another descent. One member of the pair (presumably the ♂?) goes down only halfway. Goes blue-ish during first part of descent. Then shows Mudriff while hovering. Resumes Ord (+?) on rise.

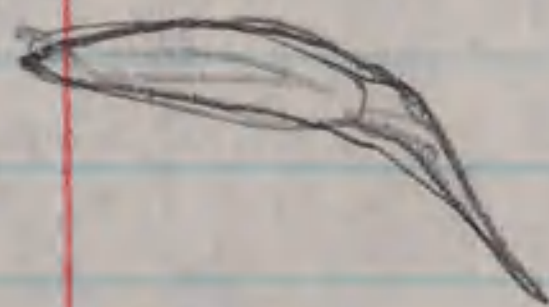
NOTE: It is quite remarkable how little white, pale, or silver that these animals show in circumstances of this type. Obviously an adaptation against predators.

10:14 Pair move away. Only briefly. Back almost immediately. They are still very obscure to me. But A says that the relations between the ♂ and the ♀ of the pair are rather peculiar. The ♂ seems to be much more enthusiastic about egg-laying than is the ♀. He goes up and down more frequently than she does. ♀ seems to be reluctant to enter crevice(s).

COMMENT: This is good evidence that ♂ "indicates" nest site. It even suggests that he may choose the site.

10:30 Get fairly close to the animals. Now there are 4. Apparently 2 pairs. All more or less in Ord (+?). I see some interactions between pairs. Advances and retreats. With little or no color changes. But some "Downward Pointing".

Especially, I think by the ♂ of the pair that we have been following most of the time since 9:52.



find any.

A finally goes forward to look for eggs 10:28. Doesn't

Ceph., July 7, 1981, II.

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A comes out of water 10:45. Aggie tows back toward tip. Nothing more of relevance. We stop 11:12 a.m.

Guam,
July 9, 1981

Going to try a new area this morning. Looking for "Double Reef", approximately 3 1/2 miles north of Tanguisson ("LCS") beach. The weather is good. Mixed sunshine and rain. Winds are light. The sea is unusually smooth.

A starts tow general area 10:40 a.m. Finds group of Sepiots 10:52. Approximately 12 inds. of medium size. In 20 ft of water, over sand and rubble. They move away. I get out of water. A continues to follow. They are dull.

11:05. A resumes towing. We zigzag back and forth in an attempt to find Double Reef. (NOTE: a local diver has told us that he often sees Sepia latimanus in this area.) We are not particularly successful. A finds something which might be the reef in question ca. 11:25. But it is 50 ft down.

NOTE: A says that water is unusually clear here, except near the surface where it is often "milky". This may be typical of many areas around the island. If so, it may help to explain why the local Lissomina often go high in retreat. They are trying to disappear from the view of a predator (in the water).

12:20 p.m. A finds another group. 50+ inds. At least 2 large, but most of the animals are medium to small. Very close inshore. High in 3 ft of water. In diagonal line (no conspicuous size gradient). All in "Ord". Rather dark and brownish. Several have spade. No Y or PCA or even WS (definite).

Most of the animals seem to be resting very peacefully indeed. They are not bothered by us. I.E. this close inshore environment must be relatively safe for them, at least during the daytime.

None of the inds. makes any attempt to feed.

Perhaps this rather dark brown version of "Ord" is equivalent to some of the "Darks" of sepioides ??? If so, it is interesting that it is less exaggerated in form (it is not so extremely dark). It is not only the light patterns of this species (or population) that are comparatively simple.

The fins of at least some inds. are also semi-dark. And so are the

Ceph., July 9, 1981, II.

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in bellies.

All in the mds. assume mild "upward pointing" and "downward pointing" postures from time to time. I think that all these postures are unritualized. The animals are simply rocking in the swell.

One ind. has a conspicuous white spot on the "tail". This could be RL; but (again) I think that it is merely a scar.

Then one ind. shows a "new" pattern. A streak along side of body, more or less at base of fins, turns bluish "semi-Pastel". The effect is slightly - but only slightly - reminiscent of some Double or Quadruple Streak patterns of sepioides. I doubt if any strict homology is involved. The same ind. turns bluish "semi-Pastel" all over, or at least on the back, while it makes a sudden retreat of a few ft.

I see that there are many half-beaks with the squid now. Not the short-billed species (see p. 43). These animals have a conspicuously long bill. They are just below the surface, usually higher than the squids. The two species may not be really integrated, socially, but they certainly are very close together in space. Perhaps the half-beaks have also taken refuge in order to rest?

ADDITION: the eyes of the squids here are pale. Conspicuous against the semi-dark of the head and body. But not at all silver. And still no ?

Every once in a while, an individual will do some brief writhing of the arms. Presumably cleaning.

We gradually drift closer to the animals. I notice that the ocelli on the back are conspicuous close up. Look blue under water.

(Again) an ind. shows bluish "semi-Pastel" with brief retreat.

NOTE: there are numbers of sardines around. But they are comparatively large. And the squids show no interest in them.

A goes for his gun and re-approaches group in order to collect specimens.

First, 2 inds. retreat slowly before him with bluish side streaks (as described above). In one case, the bluish spreads over whole rear half of body (a sort of "pseudo-Peel").

Then 10-12 members of a whole sub-group dash off in full "semi-Pastel".

A narrows in on one particular pair. (Probably a real pair. Later on, both A and Aggie see the same inds. prospecting an egg-site. Perhaps even copul.

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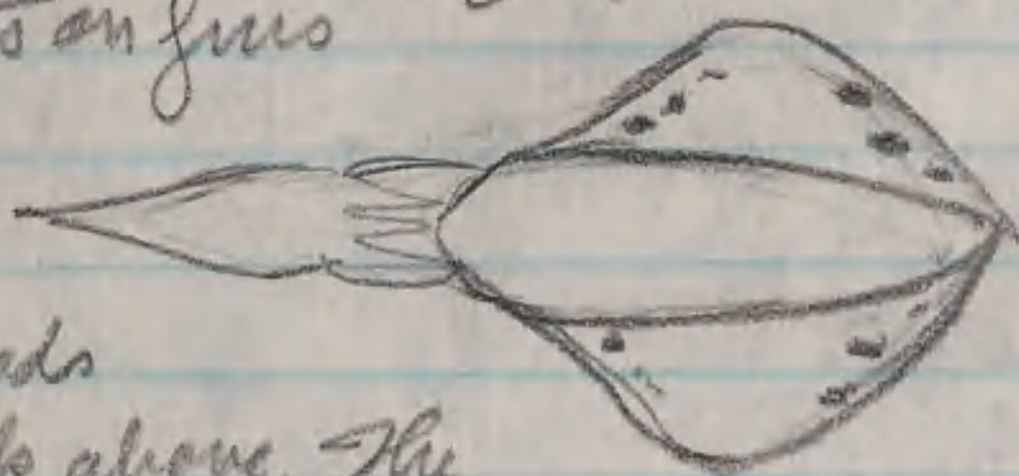
ating. SAN.) The members of this pair retreat slowly in "semi-Retire" with extreme Y (silver as usual). Is Y higher intensity in Lepidoteuthis than in sepioides? One ind. (the ♂?) then changes into Indruff.

COMMENT: these patterns in these circumstances obviously have implications. We may assume that some or all of the color patterns that we see during courtship and egg-laying are really alarm rather than sex.

A shoots at one of the members of the pair. Misses. Pair retreats several meters, no more. (And there are still other members of the group around in the background. The animals are really difficult to speak in these particular circumstances.)

A follows pair and approaches again. (Now is when the sexual behavior was seen.) Finally shoots 12:45 pm. Successful. Gets the ind. which was playing what we assume to be the ♂ role.

I see the animal on the spear immediately after being shot. Dark above. Light below. Fin with conspicuous, sharply defined BB outside. Narrow WB inside BB. Also black spots on fins.



The animal also partly spreads arms. The top arms are dark above. The bottom arms and/or the bottoms of the top arms are conspicuously light or white. (NOTE: this complex of patterns certainly is reminiscent of the full, regular, spread display; but I am by no means certain that it is identical in all respects.)

After some minutes, the animal is obviously moribund. Generally colorless. But with extremely emerald green form of Y! (Why does usual Y look so silver in the field?)

ADDITION: The measurements of the collected animal were as follows:

Mantle length: 180 mm

3rd right arm: 73 mm

2nd right arm: 48 mm

1st right arm: 63 mm

Ceph.

Guam,
July 10, 1981

Going to try same area (north of Tanguisson) again this morning. Weather is clear and hot. Sea is very smooth.

Starting towing 10:10 a.m. Along a considerable stretch of coast. Then we find the real Double Reef. Circle around and continue. Nothing of interest.

11:53 a.m. Aggie finds a large group of Sepiots. 45 inds. Ranging from large to fairly small. Apparently no newly hatched or "larval" types. In more or less shallow water (3-10 ft down) very near shore, over coral and mixed sand-coral bottoms. All strung out in wavy lines. Probably include several sub-groups, but not easy to distinguish.

When I first see inds, they are in "neutral" Ord +. With at least WS and a trace of PCA. Definitely no Y. (Y must be higher intensity in this population than among the sepioides of the San Blas.) Also slight Downward Counting.

Then all the individuals that I can see go Dark (= dark brown Ord of some earlier notes). At the same time, they allow me to drift closer to them.

This sequence is suggestive. Ord + probably contains an element of alarm which is absent (or weaker) in the "resting mid-day Dark".

One ind. advances slowly forward and upward. Extending arms and perhaps tentacles. Then accelerates almost vertically. Stops abruptly, then sinks down again. There was no real strike by tentacles, but the whole behavior certainly looked like feeding. The animal may well have caught a copepod or some other small organism. In any case, it remained in Dark throughout.

Now I see that there is some "counting". One ind. does extreme E without color change (i.e. still in Dark). Then presumed ♂ and ♀ swim together. The ♂, at least, shows a trace of blue-ish semi-Pastel.

Then I see another E. Plus 2 more E's in succession by another ind. Then an E by a (third or fourth) ind. E's obviously are common in this population. Presumably low intensity. Difficult to tell what provokes them. Possibly only a slight approach by a neighbor.

The Darks certainly extend to fins and belly. The ocelli on back are sometimes conspicuous (close up); sometimes not. This variation may be an effect

Ceph., July 10, 1981, II.

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of light rather than contraction and expansion of pigment cells.

More E's in distance.

One sub-section of group makes brief retreat in "semi-Pastel". I notice that belly is lighter than back in this pattern.

Watching 4 inds., perhaps 2 pairs, at one end of line. They all go from Dark to Ord +, with WS, PCA, and conspicuous WML. Then one assumes "semi-Pastel". At which point, there is brief, very rapid, interaction which I cannot follow. Perhaps including spread. I can't see accompanying color; but it certainly is not (full) Z.

Another E in Dark. NOTE: E's are usually performed when an animal is stationary, descending, or advancing. Seldom or never when it is going backward. Was this also true of sepioides?

One ind. suddenly turns Silver below and at least Lateral Silver above. (Actually, I would not be surprised if the upper pattern were Bilateral.) Nothing more happens; and the individual quickly resumes Dark.

A starts photographing 12:25 p.m.

Several inds. retreat slowly with a "Pastel RL" in Dark. Quite definite. At same time, belly may become slightly lighter (and reddish in tone). Then I see more "Pastel RL"s. Obviously a low intensity indication of full "semi-Pastel".

12:43 A sees courting couple in group. SAN.

Then I see burst of "courtship" in sub-group of 6-7 inds. Swimming back and forth in short arcs. Not really Rocking. Frequent brief accelerations. Miscellaneous "Pastels". One (Bi) Lateral Silver. Also one "strike" (cop?) from below.

Some distance away, I see an apparently single ind. making repeated descents (some with E's) toward what may be a (prospective) mate site. Could this be mate of ind. shot yesterday?? Its behavior is rather more reminiscent of a ♂ in a pair than of a ♀ in a pair.

Then find group of approximately 12 short-jawed Halargales in the Sepeet group. The fishes are all bunched together. Only a few inches apart from one another, at best. They are much closer to one another than they are to the nearest squid. Or than the squids are to one another. But they are

Ceph., July 10, 1981, III,

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definitely well integrated members of the mixed group. Move back and forth with the line of squids. (Although they are not always facing in the same direction. After all, they cannot swim backward.) According to Aggie, these halfbeaks were already with the group when it was first seen at 11:53.

The halfbeaks are near center of group. I.E. They probably are associating with the squids rather than the reverse.

I get out of water 1:05 p.m. A packs up shortly afterwards.

Guam,
July 12 and 13, 1981.

Yesterday we went north from the Agaña yacht basin. Windy and rough. A begins tow from Das Amantes Point around Surmon Bay 10:38 a.m.

There are lots of divers in the water here.

11:00 a.m. A sees group of approximately 8 Medium Sepiots. They leave immediately.

11:20. A sees octopus in display. In Flamboyant with papillae erected and conspicuous. Then turns Dark with White Line Down center (between eyes). Then escapes into hole. This display may have been provoked by 4 or 5 adjacent goatfishes who may have been bothering the octopus. (NOTE: these goatfishes probably are not the same species that associates with Sepioteuthis lessoniana.)

A little later and further on, A sees 2 more Sepiots. Again loses them almost immediately.

Tow continues past Ypao Point.

Stop 12:00 m.

This morning we went south from Agaña basin. Sunny and less wind than yesterday. A begins tow 9:14 a.m. Continues almost to Piti (with a detour around Camel Island). Sees only 1 squid. Stops 10:30 a.m.

ADDITION: I have been talking to a student ichthyologist here. His name is Rob Myers (spelling uncertain). He has some interesting information:
① The Short-jawed Halfbeak Melapodaion breve has not yet been

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recorded officially from Guam.

(2) The goatfish with sepioto probably is Mulloidichthys
flavolineatus. According to Myers, ind. of the species sometimes have, some-
times do not, have black spots (see p. 43). He also says that the black spots
are typical of solitary individuals, while ind. usually do not show spots
when in groups of their own species. Are the spots hostile? Alarm? A
says that the goatfishes with squids are seldom or never unaccompanied by
companions of their own species — and yet they do show black spots. Why?
Are they intimidated by the squids?

CephalopodaPalau,
July 15, 1981

Arrived Palau this morning. Staying at Micronesian Mariculture Demonstration Center on Malakal Island.

There were Sepiots by the seawall this morning — just as in 1979.

We did not have time to make observations today. But we did talk to some of the Palauans who work at the lab. One of them (Marcus) told us two interesting things:

① Local fishermen catch the squid (presumably Sepioteuthis) with hooks attached to lures carved to look like shrimp. Small squids go for small shrimp. Large squids go for large shrimp.

② Local fishermen also spear squids at night. They find the squids in groups in the shallows!

Palau,
July 16, 1981

A looked along the seawall here ca 6:30 a.m. No squid yet. I start out along wall myself 7:15. Calm. Tide is high.

7:33. See group 7-8 medium-small Sepiots. High in water column clustered near rear of boat (taking "shelter"?). More or less pale-ish (pastelish?) Ord + Suddenly all retreat. Go lighter as they go. Disappear from view temporarily.

NOTE: Bruce Saunders says that he also has seen Sepia (large) by the wall. Presumably apart from the squids.

Group of small medium Sepiots in boat. At least 12 inds. now. First in darkish Ord (+?). Then turn paler, "semi-Pastel", as they approach boat again. Then disappear again.

NOTE: Saunders says that he has already sent specimens of local squids and cuttlefishes to Roper.

COMMENT: On the little evidence that we now have, it would appear that cuttlefishes and squids are closer here than at Gaiin.

Ceph., July 16, 1981, II.

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7:45. Wind rising a little. Direct sunlight is beginning to reach this area (sunrise was before 6:00 a.m.).

Lots of sardines in inlet at end of wall.

Stopping 8:20. Too many ripples in water.

12:05 p.m. Walking along seawall again. Group of 40+ Sepiots. All in diagonal line. Small (in front) → mediums or medium-large. Some distance below surface. All in dark. Obviously basking.

Becki (spelling?), one of the technicians here, catches (with hook) 5 of the squids in rapid succession. Using black shrimp-like lure. I.E. these animals certainly are prepared to feed in the daytime!

We keep one of the squids for identification.

This afternoon we go out by boat. A does extensive towing, from 1:35 to 3:20 p.m. Along shores of Winkthapel, a rock island south of Malakal; then along south shore of Malakal (including seawall of Center); then along a rock island (name unknown) west of Malakal. Water is not very clear; and he does not see any squid or cuttlefish.

Palau,

July 17, 1981

A got up early this morning. Before 6:00 a.m., just getting light. He sees group of 7 large Sepiots by seawall. Apparently feeding on sardines. He sees feeding advances, but no actual captures. But the sardines certainly reacted as if they were being attacked. The squids seemed to be more or less Ord between advances. Perhaps turned colorless (or light-ish?) during advances.

Later, ca. 8:30, A finds group Sepiots in inlet. At least 8 large, several smaller. This time, he does see a large catfish sardine.

When I start observation, 8:40. Group is still there. All more or less in Ord +

Retreat before carangids with little or no color change.

Ord + includes WS and PCA. Also spade in some cases.

NOTE: Becki is already catching more squids down the wall.

Ceph., July 17, 1981, II

(54)

We probably caught 30 inds. yesterday. The population of Sepiots must be enormous here to withstand this sort of pressure.

8:57 Group includes at least 15 inds. Relaxed and dispersed now. Inds. may also be turning slightly lighter. WS and PCA no longer conspicuous. Carangids seem to have gone. And feeding has stopped (at least for the moment).

NOTE: it is cloudy today. May help to explain absence of Dark.

One ind. turns briefly yellowish with slight retreat.

Something - not the squids - is making sardines jump by far bank. WS has also reappeared on squids. Is this coincidence?

I walk along seawall for a while. Come back to find group in inlet still behaving as before. All very placid 9:12.

Carangids back. Several squids go Dark immediately. But they do not retreat.

Then squids retreat in light-ish when sardines leap particularly closely. Relax again.

No sign of courtship (yet).

One ind. turns "tear" with conspicuous WS. Then immediately very Dark. Then immediately back to Ord-ish. This ind. has companion close by. Was the interaction hostile?

Walk along seawall again. Nothing of interest. Back to inlet. Everything just the same 9:40.

2 adjacent inds. go Dark, briefly, simultaneously. This sort of performance is common, I think. Some Darkes do seem to be "social".

Stopping 9:55 a.m.

11:20. Group of 20 large Sepiots by seawall. In dark-Ord. No WS (definite). Basking near surface. (Tide is low. Sun coming out.) This may be group in inlet earlier. (Inlet seems to be empty now.)

NOTE: ink ejected in water earlier - possibly much earlier - is retaining consistency remarkably well.

We decide to go into water 11:37. First swim over shallow "seine" just west of Center. Water is murky. No cephalopods visible.

Then we take boat and go out to Winkthapel again. A tow along

Ceph., July 17, 1981, III.

(53)

outer shore (we did the inner yesterday). A starts tow 12:40. Finds one small 12:50. Then a small ink blot a few minutes later and a few yards further on. Nothing more. Gets out of water 1:33 p.m.

We see 2 additional snails, close together, on way back along same coast

COMMENT: the typical "rock islands" here would appear to be poor in Sepiots (except possibly fairly well developed young). Why? Perhaps because the fall-off from them is too steep ??? (Note that there is a quite fall off, with sand and coral in front of the seawall of the Mariculture Center here. And, although there was very deep water nearby at some of the sites where Sepiots were found at Guam, the individuals observed were always - at least usually - in shallow waters at the times of observation.)

There are Sepiots, basking in Dark, by seawall when we get back to Center at 2:30 p.m. Tide very, very low.

I go out to seawall again 5:00 p.m. Tide rising now.

Nothing visible by 5:25 (but reflections on water are very bright).

Out again to seawall 6:18 p.m. Lots of blue-ish carangids jumping about. Apparently a feeding frenzy! Then they all rush off. In pursuit of squids? No ink in water.

Lots of noddies feeding farther out. On sardines?

Nothing else of interest visible. Beginning to get dark now. Stop 6:32 p.m.

Palau,
July 18, 1981

Out to seawall 7:33 a.m. Calm weather, but some boat traffic. Tide is high. Water murky in inlet.

8:04. 2 mediums or small mediums show up. High in water. 5 ft apart. In Ord with Y (little or no WS). Apparently making feeding advances. Not very vigorous. To copepods.

Then A finds large group (45+) further down wall. Mediums and larvae. Lower in water column.

Apparently gone when I get there.

Ceph, July 18, 1981, II

(56)

Stop 8:30 a.m.

Start with boat 9:00 a.m. A tours back and forth near Center. Over very extensive sand and coral. Slope is gentle.

There are many blobs of ink, of all sizes, here. Is this profusion significant? Are the squids here particularly heavily preyed upon - and/or particularly "spooky"?

In the course of this tour, A sees one group of 13 Sepiots, large to medium. Also another group of 24 smalls. SAR.

Becki starts fishing and so we go out to other areas. Channel between Malakal and Koror. Then out to offshore islands, within lagoon, lee side of the archipelago, more or less facing channel. Again A tours over great variety of habitats, mostly coral and sand, some TG (apparently not Thalassia - more like Enhalus in appearance. Water murky in some places; quite clear in others. A sees occasional small groups of squids and/or ink blobs. Nothing of real interest.

We stop work 12:03 p.m.

NOTE: We are still failing to see any very young "larval" Sepiots. Why? It might be supposed that the young of Lusomana hatch at a more advanced stage than do those of sepioides. But this seems unlikely. According to A, the eggs of Lusomana appear to be approximately the same size as those of sepioides.

Out to seawall again 4:30 p.m. Tide very low. Swimmers around. But some one says that they have seen squid.

Then I see groups of large Sepiots. All very near bottom. All in pairs. Dark. One suddenly shows lateral silver while swimming past another. Then dark again.

I go into water 4:15 p.m. Visibility is not good. In any case, by the time that I get to the appropriate area, the squids seem to have gone.

I swim up and down the length of the seawall, without seeing any cephalopods. But A tells me that the same group of 7 large Sepiots appeared again after I had passed.

Out of water 5:00 p.m.

Palau,
July 19, 1981

Out to seawall 8:25.

Almost immediately see group of 34 large-ids. Bunched close together. Barking near surface in semi-dark with little or no WS. Then all retreat in pale-ids. With Y, I think. Then relax. Then off again without color change.

I walk back and forth along wall.

9:00. Group reappears same place as before. Now in diagonal line. In semi-dark again. Then scatter a little without color change. Drift away again.

Some minutes later, I see large school of carangids 100 ft along wall.

Group back 9:20. Barking in Dark. Rather scattered. Some indication of pairs?

One ind. shows brief, faint, Bilateral Silver. Another shows brief trace of "yellow."

One ind. backs toward another. Generally darkish, but fins have gone light and transparent with conspicuous diffuse BB.

Then all sink down, going slightly lighter, into neutral Ord. Is this cryptic? All inds. are facing out into lagoon. One or two have Y. Is there predator in lagoon?

The inds. stay low, but gradually get darker.

Brief retreat with slight palming. Back to darkish. And to surface 9:32.

All dash away in "pale" Back again in Dark. Then go down and turn Ord again. Still little or no WS. Up and Dark again.

COMMENT: These inds. go down to go cryptic. Unlike the animals at Guam which went up.

NOTE: inds. tend to keep relative position in line. One large with scar is usually 4-6 positions from one end of group. Larger inds. are usually clustered toward center.

Group is decreasing. Now only 12. 9:45. Then more drift in again.

Ceph., July 19, 1981, II.

(58)

NOTE: fins definitely are dark all over in usual dark.

7:50. Breeze coming up. Ripples on water.

Still no trace of counterstip of any appreciable intensity.

Taking a break 9:00 a.m. Back 10:30. Tide going down. Water still rippling. Squids apparently gone from former site.

Huge school of sardines in inlet. Apparently no squid. But then sardines are briefly attacked by school of carangids.

Stopping 10:50 a.m.

Go out to lunch. Come back ca 1:15 p.m. To find that Leroy has caught a tiny little cephalopod. In about 1 ft of water over ramp at (Marine Resources Development Board) boatyard in Koror.

General shape is Sepioid and/or cuttlefish like. Shining light on the animal in lab, it appears to have something like a solid cuttlebone inside. But it also seems to have 2 little fins approx $\frac{3}{4}$ of the way back on the body!

At the present time, the upper surface of the body is generally brownish yellow, thickly and almost uniformly covered with small light (white and/or iridescent) round spots.

The animal would appear to have a mantle length of approximately 8 mm. Head and arms possibly also 8 mm.

When I look again, the animal has turned more or less yellowish colorless.

Actually, the animal looks too elongated to be a larval Sepioid. Nor does it have the relatively few and large chromatophores of larval sepioides.

Sometimes hangs head down (straight).

According to A, shows occasional flashes of lighter or darker. Also "fin stripes" (along whole side of body) and down sides of arms. See A's drawing.

In microscope dish, the animal goes absolutely colorless to the naked eye. Transparent jelly. Under microscope, however, one can see many black chromatophores in extreme contraction.

Animal remains colorless, similar to bottom of tank. Seems to be dying.
2:25 p.m.

Ceph., July 17, 1981, III

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Then the animal starts to move around. Jerkily and abnormally. Still in colorless almost all the time. Occasional very brief, instantaneous, flush of dark. Turn out light and leave animal alone 3:00 pm.

Still alive at 3:45. Then Leroy puts in warmer water. Animal partly revives. Starts to swim above bottom. Begins to get a little color. So we take aquarium out of air conditioned room and put it in room without air conditioning.

4:04. Now animal has gone colorless again. But it is definitely swimming, jerkily above bottom.

We ladle in more natural sea water. Animal becomes more active - probably in reaction to disturbance. Once it jumps, shoots away, briefly turns full dark. Then colorless again. NOTE: its colorless may have a tinge of yellow now. 4:20.

Now animal is swimming less jerkily. Assumes diagonal head-down posture. Once extends tentacles. Feeding on something microscopic?

Still in colorless, shows occasional trace of "fin stripe" and/or dark lateral arm stripes ("LAS"). Eventually, these become semi-permanent. Then animal rises toward surface in head-down.

This is at least a partial recovery.

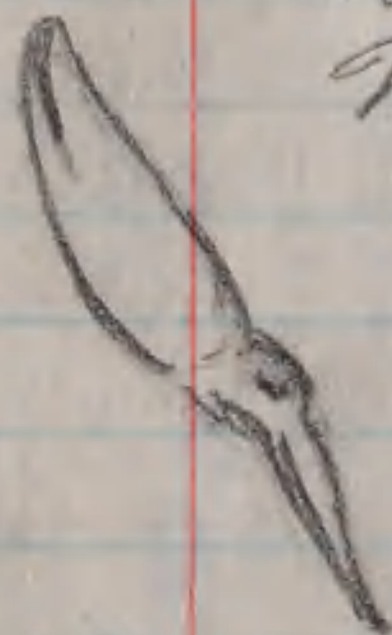
"Fin Stripe" usually or always restricted to rear half of body. Could they be related to DM of other species?? Animal also begins to darken (to something like Ord of Sepiots) spontaneously from time to time.

Almost touching surface now 4:38

Angle of usual head-down is

This posture probably is not
not as a signal.

Sometimes almost vertical
"ritualized" - at least



Obviously watching me outside tank

Yes! "Fin Stripe" as shown at present (possibly different from stripe shown in A's drawing)

Sometimes shows tendency to curl distal parts of arms downward. In a sort of adumbration of an E.

There is no doubt that this individual prefers the surface where it is undisturbed (and healthy). Goes down a little when new water is poured in.

Ceph., July 19, 1981, IV.

(60)

Now protruding tentacles, usually only part way, in regular and rather rapid rhythm. Tentacles are often Dark with White Tips. They also appear to be entirely Dark on other occasions. Once apparently in response to my approach. Some times the tips of the tentacles are spread and curled like hooks. Usually with Dark?

The animal seems to have chromatophores within the body as well as in epidermis.

Now there are more instances of continuous Fin Stripes. Are Fin Stripes and DM poorly differentiated in this species and/or at this stage?

Later on, arms and tentacles are often partly retracted. Into a blob.

Terminal and subterminal Dark of tentacles quite invisible. This might be a sign of relaxation or "sleep".

5:31. Animal extends tentacles several times again. These times, the tentacles are entirely colorless. I.E. both Dark and WT of tentacles at other times are actually assumed.

Once the animal protrudes arms in "Anchor" while they are (still) entirely colorless. Definite.

Then does the same thing again and again. This obviously is important. After each Anchor protrusion the tentacles are down into the cone or blob of the other arms. Looks almost like "sucking". Is microscoping food adhering to the tentacles when they are spread in anchor??? Are tentacles sticky?

A photos 5:45 pm.

GENERAL COMMENT: the colorless or semi-colorless of this animal seems to be a sign of (relative) relaxation. The Dark seems to be a reaction to disturbance. Sometimes, at least, accompanied by retreat (insofar as the animal is able to retreat in its present circumstances). Possibly a Pale for retreat will develop as the animal gets older?

More Anchors. Usual form is more extreme than diagrams above. Comme ça:



perhaps sometimes longer.

No real signs of "struttes" as in the feeding attacks of Sepioteuthis and sepioides.

Ceph., July 17, 1981, V.

(61)

Several times, animal approaches wall of cage, arms first, repeatedly. Could it be picking something (food) off walls.

Observations interrupted 4:26. Noah has found a Sepia off seawall. I go to look. Really just a grayish mass in this light. Almost on bottom (Tide is getting high again.) Apparently alone. Certainly no Sepiots visible in the neighborhood. Gradually moves on. Lost to view.

NOTES: Noah says that this animal is less than half large adult size. He also says that it is typical for the cuttlefishes to come at dusk and leave at dawn.

Back to our small captive 6:37. Still behaving as before.

6:45 p.m. Leroy puts lots of microscopic food in aquarium. Our animal starts to feed immediately. Mostly "mubbling" at the walls; i.e. repeatedly approaching and touching walls (bumping into them) with its arms - not the tentacles. Leroy thinks that it may be taking clam larvae.

We turn out lights and leave 7:10 p.m.

I think that I will call both the individual and the species Oskar for the time being.

We go over to look at Oskar 8:20. Without turning on the lights. The animal certainly is not luminescent. So we use our flashlights. Find the animal high in water column, backed into corner, in "On" or semi-Dark. Turns lighter when we shine light on him. All the time, his arms are in Blob. We leave immediately.

NOTE: It is conceivable that Sepia and Sepioteuthis share the same close inshore habitats by alternating night and day.

Palau,
July 20, 1981

Out to sea wall 5:30 a.m. Just getting light.

The cuttlefish seems to have gone. And the Sepiots apparently have not arrived yet.

5:55. Now we see large group of Sepiots. About 20 ft from wall. A sub-group comes closer and then disappears again.

6:07. Oscar seems to be alive and well. Near surface. Infinitely yellowish colorless with Blob. Then starts to nibble from walls, just like yesterday. Still using arms alone — or tentacles retracted so that they do not protrude visibly beyond the (other) arms.

Feeding low as well as high on walls.

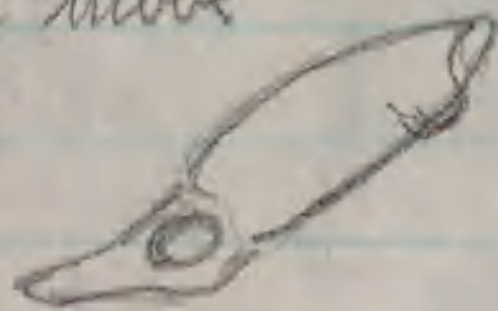
NOTE: aquarium is Japanese, but approximately 10 gals.

Nibbling is nearly constant. But I have yet to see any Anchor this morning. Is nibbling common in wild? If so, the species can hardly be open water at this stage in its life history.

6:22. Now the animal has definite Fin stripe while feeding. The stripe was not present earlier.

Most of the nibbl
head and arms are

Comme ça:



ing is not in head-down. Body is tilted, but bent at an angle.

Stopping observations 6:30

6:32 a.m. Two fluids & cuttlefish. In approximate area where ind. was seen yesterday. Mass of curving steel beams (old Quonset Hut?). One ind. may be the one seen yesterday. The other is (even) smaller. About 15 ft apart from one another.

Both are very placid. Just hovering above bottom in usual Sepia resting posture, arms pointed downward and tucked in.

When first seen, both inds. are in sort of muddy, semi-mottled "Ord" incredibly cryptic. After a minute or so, larger ind. turns dark, with raised white papillae all over back. And conspicuously light eyebrow ridges. Y?

6:44 Group of 10 Sepiots (large-ish) appears. Near surface, more or less directly over cutties. But the 2 species are not close together. Tide is high now. Water probably 10 ft deep. Squids are in dark-ish as usual. Smaller cuttle is staying in same color throughout. The larger cuttle shows brief "center" or "midriff" Bar (i.e. part of back turns lighter than it was). This could be coincidence, or a reaction to the squids, or (perhaps more probably) to a surge of waves (a motorboat has passed by).

Group of Sepiots is now 21. All in Dark at surface. (Note that today is cloudy, not bright sun). The Sepiots drift over the cutties. No visible re-

Ceph., July 20, 1981, III.

(43)

action by anyone

6:50. Larger cuttle changes color. Head goes paler. Develops light center Bar across back. And papillae disappear. A says that animal caught silver fish at this time. Then the animal goes back to "usual" dark with raised white papillae.

One eyebrow of the larger cuttle is consistently lighter than the other eyebrow. Could this be scar?

6:58. Sepiota seem to have drifted away for the moment. The cuttles are just sitting. Then one turns dark all over - i.e. lowers papillae (?). Just a brief flash. Goes back as before. Both cuttles seem to ignore passing fishes (none of which are sword-fishes).

Papillae may be getting gradually less conspicuous now 7:07.

NOTE: the gardens here look rather like the ribs of large palm leaves. According to A, some of the cuttles of Guam tend to hang around similar palm leaves.

Leaving temporarily 7:10

Back 7:30. The 2 cuttles are still here. Just as before. CORRECTION: the smaller cuttle may have gone (at least, I can't see it). But the larger ind. is still visible (from our point of view).

The large school of carangids swims by. Shows no interest in cuttle. And the cuttle does not react to them.

Papillae of cuttle certainly are relatively less conspicuous now.

Stopping again 7:50. Go over to look at Oscar. Also still very much as before. But perhaps feeding less actively. In pure colorless at first. Then develops conspicuous Fin Stripe and Arm Stripe. These are essentially (or visually) continuous with one another. I can't see what provokes this performance (perhaps my appearance?). But stripes soon disappear. Back to colorless. Arms in Blob. And animal goes back to nibbling.

Why are there no Anchors today? A change in food supply?

Now the animal is just floating half way up in water column. In dorsal up head-down. Perhaps resting. But still in colorless. No trace of dark.

Suddenly shows Fin-Arm Stripe, briefly, when I make brusque movement. With very slight retreat. Then stripes must be hostile. Presumably very mild alarm.

The animal resumes pure colorless as before. Colorless must be remarkably cryptic in the field. Presumably Pale will develop when internal organs have become so large.

Ceph., July 20, 1981, IV.

(64)

Now animal is resting in posture comme ça:



A says that large Cuttle is still in place as before

8:21 Oscar suddenly flushes Dark all over. A reaction to our approach?
Then back to colorless

A is going to change some of water and put in new food.

Now Oscar shows a Dark flush when I am absolutely immobile. There is no accompanying retreat or advance. In fact, the animal also is immobile for the moment 1/3 up in water column. Apparently sound asleep. Having dreams?

Oscar certainly is not resting near surface today. If this is normal, it may be protective against birds in natural circumstances.

8:30. While I am out of the room for a few minutes, A puts new water and more food in aquarium. Oscar starts nibbling vigorously again. With usual movements and Blob arrangement of arms.

Feeding is absolutely continuous. The animal is going meticulously around tank stopping observations 9:03 am.

10:15. A says that both cuttles are still there by the wall.

I go over to look at Oscar. Find it in colorless diagonal head-down near bottom of tank. Sinks slowly forward. Then studies at bottom. Using tentacles, I think. Apparently catches prey. Apparently after brief struggle. Then retreats upward again. Still no color change.

This type of feeding behavior might well be cuttle-fish-like.

Going away again 10:30

At noon, Leroy and I go over to boat ramp where he caught Oscar yesterday. Start looking for more Oscars on boat ramp and seaplane ramp. 12:35 pm. But then I investigate nearby shallows. Rock and old concrete bottom. Gentle slope. And I find another Oscar right away!

Ind. is in less than 1 ft. of water. Floating gently in head-down and full Dark. Presumably basking in these circumstances. Definitely alone. Apparently not feeding. Arms possibly in Blob.

We catch this ind 12:55. Bring it back to lab. Put (open topped) can into aquarium. Newcomer does not come out.

I shall call first ind. "O" and the newcomer "OO"

After can is installed O remains in far corner for some minutes

Ceph., July 20, 1981, V.

(45)

In "downward pointing type of head-down.
less pure colorless.

In more or

Then O suddenly advances toward can. At same time assumes down
Stripe without Fin Stripe. I.E. the 2 stripe patterns are partly independent of
one another. Then assumes complete, relatively heavy, Fin Stripe with Arm Stripe.
At same time extends tentacles. Into complete Anchor. The tentacles are complet-
ely dark (no WT). When it is very close to can, it stops Anchor, turns around,
and attaches itself to the outside of the can, looking outward. Shades of young
sepioides! Loses stripes at approximately same time. Then just sits, tail to
can, with downward pointing Blob. Sometimes Blob is so
reversed that it looks almost like E

After some minutes, it turns a little more until it has its
side pressed tight against wall. As if stuck.

When I look inside the can, I see that OO is doing same thing.
Largely in colorless. But with dark smudge or "shield" on front part of
back. Perhaps also a separate smudge toward rear of back (difficult to disting-
uish from ink gland). Also partly protected under an indentation of can.

OO probably is larger than O

Both animals still sitting in same positions 2:05 p.m.

ADDITION: I noticed that the shallows near the ramps have a cons-
iderable miscellany of leaves floating at surface. Thus, even OO in Dark was
cryptic. (Leroy thinks that O probably was colorless when he caught him yesterd-
ay. He saw the shadow before he saw the animal.)

2:12. I look into can again. OO is entirely colorless at first. Then
Darkens, presumably as it sees me. Dark seems to expand from 2 dorsal
"streaks". Vg. A's sketch yesterday. Then relaxes partly. Retains dark
smudge front of back. Also separate smudge to rear, in region of ink gland.

2:15. O leaves can. Starts to swim around. Drifts over top of can.
Must see OO down below. O immediately assumes strong Arm and Fin Stripes
In HD. With extreme Anchor, tentacles very dark. Then backs off. Re-
sumes colorless. A few minutes later, drifts over can again. And again assumes
Stripes and dark Anchor. Then goes further on. Reassumes colorless and starts
mubbling. Apparently undisturbed.

Ceph., July 20, 1981, VI

(66)

As far as I can tell, from a few brief glimpses, O stays the same throughout this sequence. Still with smudges.

I look up after writing these notes to find that O has returned and attached itself to the outside of the can again. But now it is Dark, upside down, and facing inward!!!
Rather like a woodpecker!!!



O gradually gets lighter over the next 5 minutes or so. But it has not yet (2:35) resumed full colorless.

What is the significance of Dark and semi-Dark in these circumstances? Is it coincidental that the animal is attached to a Dark (Bright red) part of the can now. While earlier, in colorless, it was attached to a light (white) part of the can ???

Then O moves to another red part of can. Here it attaches itself in more "normal" position, tail in, arms down, but still retains semi-Dark 2:40 p.m.

O doesn't seem to have changed at all.

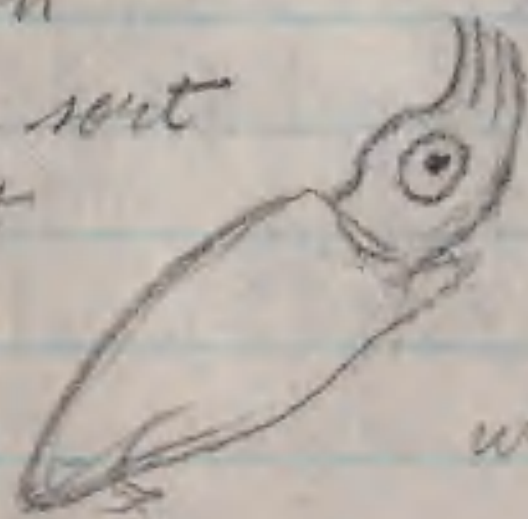
O moves itself and swims around can. At first still in semi-Dark. Then changes into colorless when it gets to white part of can. (Note: the bear is Budweiser). Continues swimming. Several times pure colorless is interrupted by Fin Stripe and/or Arm Stripe and/or dark Anchor.

Then O goes feeding in colorless again. Mubbling as usual.

3:18. O swims around can again. Dark near red, then goes colorless near white. Then settles on white. And assumes distinctive posture. This is the posture that I called "upside down" (and compared to woodpecker) above. My earlier description would seem to have been wrong. At least now, the end.

is not upside down. The back is on top. Only the arms are held up in a sort of curl. (The posture is so difficult to be right in center of side of

This posture may be some sort of sessile organism.



of a combination of an upward to decipher because the eyes seem head. Not noticeably high or low. will be cryptic in itself. Mimicry of

Could the animal also be catching micro-organisms in this position?

Ceph., July 20, 1981, VII.

67

The arms often are slightly spread and moved about a little

3:24. O starts to swim. Assumes Stripes, then Dark when I move. Then back to colorless again. Starts nibbling again.

OO still the same. Why doesn't it start to move? I am going to tip it out, leaving can in tank, 3:50 pm.

Both inds. go Dark immediately. OO retreats downward toward corner. Assumes "Upward Curl" (as drawn on preceding page, but probably more exaggerated) as it goes. O follows at a distance. In sort of E. Tentacles retracted in both Upward Curl and E. General effect of arms is still rather Blob-like in spite of curvature. OO reaches wall. Clings to it sideways. Motionless. At which point, O seems to lose interest. Also goes colorless. Then goes and nibbles at another wall.

These animals certainly do not seem to be gregarious now!

NOTE: "Colorless" of OO is yellower than that of O. Yellow may be low intensity Dark. But OO has lost its smudges.

OO seems to be quite paralyzed with fear or shock at the moment, but O seems quite relaxed

3:58. O goes and hangs in head-down, with both Arm and Fin Stripes, near OO. OO just looks at it without changing color. Then O loses stripes but continues to hang in colorless, looking at OO intently. Then moves away and feeds again.

OO remains plastered to side of tank. Head up. Tail down. Arms raised (only slightly curled now). I think that it is the belly side that is pressed to wall. In any case, this side has broad dark brown streak down center. General body color may also be becoming darker tawny. Arms also are becoming straighter.

Everything very dull 4:04.

A movement of my hand startles OO into rising diagonally in E-type posture (not necessarily extended). Full Dark all over. Then goes slightly paler. Into tawny semi-colorless with Fin and Arm Stripes and a broad dark brown Median streak on back. Streak is partly interrupted 2/3 back. Obviously a confluence of anterior and posterior "smudges." Then it suddenly starts to feed. Nibbling wall. Loses stripes, but not streak, while semi-colorless becomes somewhat lighter. Nibbles frantically, but only for a few minutes.

While this is going on, O is floating quietly in pure clear colorless on other side of tank

I may be wrong. Median streak may be on back. See latter comment.

Ceph., July 20, 1981, VIII.

(68)

Then OO stops feeding. Floats passively, head up, arms more or less horizon-
tal. Median streak is now more broken, perhaps more diffuse, than earlier.

Then O starts to swim out from wall. Assumes both Stripes and Black Anchor in HD. Snaps tentacles back abruptly. This does look like feeding. (Is Anchor "investigatory"?). Then goes over to nibble wall. Far from OO. OO itself does nothing.

Then O goes back to can, attaches itself by the tail, and then assumes semi-upward curl, all in pure colorless. Facing away from OO on opposite side of the can. The 2 animals probably cannot see one another.

All very quiet again 4:30 p.m.

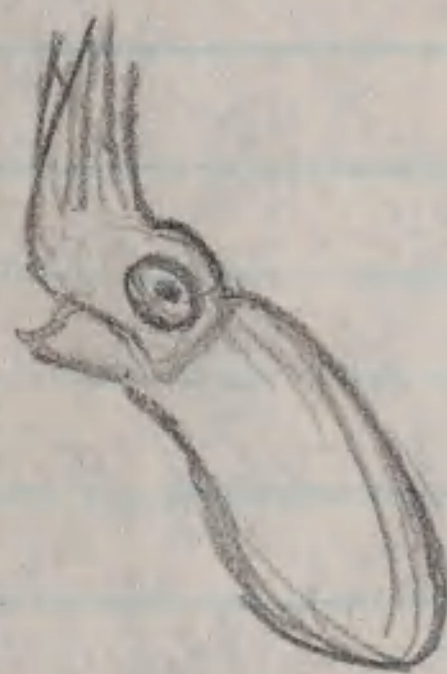
No change 4:45. Stopping observation.

Back ca 5:15 p.m. in order to add some fresh water. Find O attached to red of can and in dark. OO is just where I left it. Also much the same in color. But Median streak is paler and even more broken up.

5:25. OO suddenly leaves wall and advances toward can. With both Arm and Fin stripes, usual (for it) tawny background, tentacles extended (perhaps dark but apparently no Anchor). Median streak is strong again. Comes ca:



Then settles on can (red part) in same pattern. Raises arms. Almost like a polyp.



Note: funnel is relatively very large but quite transparent and nearly invisible.

While this is going on, O is quietly feeding, in usual colorless, some distance away.

NOTE: A says that the 2 cuttles by the seawall here were still around at mid-day and shortly before sunset.

8:57 p.m. Go over to look at Oscars. Both sound asleep. Both in Dark. Both attached to surfaces by tail. OO near bottom of one wall. O near

July 20, 1981, VIII.

69

top of beer can

Palau,
July 21, 1981

Go to look at Oscars 7:10 a.m.

Both still alive. O swimming around in clear colorless. OO attached to bottom wall. Median streak
In general tawny buff "semi-colorless." No
Is this tawny buff perhaps the beginning of an End??

Then (while I am writing), OO swims over and attaches itself to inside of beer can. Now apparently in lighter semi-colorless.

ADDITION: when Xeray was chasing O in order to catch it 2 days ago, the animal tried to escape by swimming out to deeper water, not by hiding in crevices.

OO comes out and attaches itself to outside (red) of can.

In tawny buff, extreme arm stripe, some fin stripe, definite Blob (this may be resting posture of arms). O swimming in colorless a few inches away. Then O moves off. OO may go slightly lighter, but it retains both stripes.

O now attached to outside can (white) in colorless. Probably out of sight of OO.

OO's Blob is comme ça:

Every once in a while, OO protrudes and retracts (colorless) tentacles

Not very rapidly. Could this be cleaning?

Arms really pretty spread. Looks like fiddler feeding, lophophore type, mechanism. Both Fin Stripe and Arm Stripe tending to disappear now 7:27 But then they come back again strongly.

OO certainly is less tame than O. Is this a matter of age?

OO now has small spot of dark front center of mantle. Presumably a low intensity indication of smudge (? = Median Streak?).

Then OO rises toward surface in H.D. Goes pure clear colorless



Ceph., July 21, 1981, II

(170)

(almost as clear as O) with Fin stripe and small back spot. Then goes Dark all over when I move. Tightens again. Goes into slightly tawny colorless, with back spot, no Fin stripe, starts to feed by nibbling walls. Then hangs head-up attached to wall in semi-Dark.

NOTE: This back spot may be "permanent." Could it be a scar or an internal organ showing through?

Stopping temporarily 7:42

Come back 8:05 to find both inds. attached. O in colorless white part of can. OO in Dark on glass wall. Both De novo. Then O goes swimming and Then OO goes colorless. Without part of can, in colorless as usual.

Certainly can see one another feeding. Only or mostly nibbles back spot. O reattaches to white

O goes swimming again. Immediately OO develops Fin stripe.

8:20. As a reaction to me or to O, OO develops DM. Two eyespots on either side middle of back. These may, perhaps, extend briefly to form a semi-Midriff Bar (perhaps extending to or toward belly?). Then goes Dark all over. Then relaxes in slightly buffy colorless. All without moving (And DM certainly invisible to O.)

O is feeding quite frequently, but OO apparently is not.

NOTE: A says that the cuttles have gone from wall.

A photos Oscars 8:28.

Both animals swimming around 8:45. O in colorless. OO in buffy colorless with back spot. This spot is small, circular, sharply defined and reddish.

A puts in new food 7:05. No rush to feed.

Setting out to look for Oscars in the wild 1:05 p.m. Tide is going down. Walking along mud-shingle-rock beach near old barges between MMDC and Harbour. Start 1:20. Nothing pertinent by 1:45. I go on.

Arrive boat ramp 2:00 p.m. Tide is too low to be ideal. Some wave action. Murky. But probably no more than yesterday. Lots of debris as usual.

See group of 4 small animals which look remarkably like Oscars in Dark. Unfortunately, they turn out to be fishes when I finally catch them.

Over to area where OO caught yesterday. Apparently no squids. But there certainly are bits and pieces of debris which look remarkably squid-like!

Ceph., July 21, 1981, III.

(71)

Stopping 2:30 p.m.

Stop by lab 2:50 on my way back. O swimming in colorless. OO attached low to wall. In buffy with back spot.

A found some Siphon today. SAN.

Cuttle still gone from seawall.

Back to lab 3:45. O and OO attached to different walls. O in colorless. OO in pale buffy with faint back spot. Both swim. Not together. OO nibbles. Very active. O "jiggles" up and down in head-down. OO does not change general tone during feeding. But red back spot is conspicuous now.

OO assumes Fin and Arm stripes when I move. Then relaxes and loses stripes.

The fact that the 2 inds. never come together indicates active avoidance. But there are no conspicuous evasive movements.

O starts nibbling. Still "jiggling". Why? It can hardly be quality of water as OO is resting calmly now.

O flashes away when I move, but without color change.

Then OO starts feeding again. And goes colorless except for back spot. Feeding is mostly nibbling. But 2 apparent strikes into open water. This ind. tends to swim more or less parallel to wall while nibbling. O is usually more perpendicular to wall.

Another fast retreat by O without color change. It seems to have stopped stripes as well as dark during "normal" daytime activities.

The 2 inds. are feeding as far apart from one another as possible. Color difference between them (buff vs. clear) is essentially invariable.

It is amazing that we have seen only 1 squirt of ink (by O on first day) by these animals in captivity. Probably a (mother) difference from cuttlefishes.

O extends tentacles straight, before making long distance strikes at wall. Still jiggling madly.

O gradually moves along side wall. Still nibbling in colorless. OO is now attached to end wall, in buffy with back spot. O finally approaches within an inch of OO. Remarkably little reaction. All that happens is that OO goes more needy, purplish colorless (only a slight tinge of buff, and back spot, remaining). O moves farther away. And OO goes back into deeper buffy.

O approaches again, and OO goes lighter again, but only momentarily.

Ceph., July 21, 1981, IV.

(42)

The 2 animals are almost touching now. But there is nothing more in the way of a visible interaction.

O moves off and OO becomes buffy again.

O finally goes and attaches itself to can. Colorless on white. Breathing slows. Stopping observations 4:30 p.m.

ADDITION: Leroy saw a third Oscar today. At boat ramp ca. 1:00 p.m. (i.e. some time before I arrived). Alone in Dark. In shallow water. This habitat may, therefore, that this habitat is "typical" for the species at some stage of its life cycle.

Palau,

July 22, 1981

The Oscars are still alive and apparently well 6:40 a.m. O swimming and feeding in colorless. OO attached to wall in buffy.

OO shows both stripes when I approach.

Then O paces close by OO in the course of feeding. OO responds by going colorless again. This must be significant. Then OO resumes buffy when O paces on.

Is colorless cryptic? Yes. Perhaps the animals assume either colorless and/or Dark in order to be cryptic according to the ambient illumination (in addition to physical environment).

O certainly feeds much more frequently than OO.

ADDITION: A went touring with Marcus yesterday. Found some Lepists. SAN.

OO still isn't moving 7:00 a.m. Could it be damaged?

I put some fresh water in 7:12. OO still attached in buffy with stripes. Then suddenly starts nibbling actively. First goes colorless while retaining stripes. Then loses stripes and goes almost pure colorless.

Perhaps the buffy of OO is just a "resting" coloration.

O is not feeding at the same time as OO. It just sits, attached to wall in colorless.

OO gradually gets buffy-er as feeding continues.

Ceph., July 22, 1981, IV.

(73)

O's breathing gets much slower and slighter as it rests. No real jiggling. NOTE: Octantula does not use buff as a resting coloration during the daytime.

Stopping observations temporarily 7:22.

Two cuttles back at seawall. Probably the same 2 inds seen the day before yesterday. Same sizes. In almost same places as before. Smaller is in cryptic mottled neutral. Larger is in dark with white papillae. Neither is moving visibly. (Unfortunately, visibility is not too good, as there is gas on water.)

There is a big school of sepiots near surface 150 ft away. In dull Orel. Becki starts fishing them right away. They go for the shrimp here instantaneously. Turn dark and ink when caught.

Only one, or at most two, inds. go for lure simultaneously. No disputing even when there are two. Quite sepioides-like.

NOTE: Becki says that the 2 cuttles were here yesterday.

Going for coffee 7:40

Back to lab 8:40. Both O and OO attached to wall in head-up position.

Only a few inches apart. OO in buff, O in colorless, as usual. OO drums Arm and Fin stripes when I approach. We put in new food. O starts to feed in colorless. OO does not feed.

OO apparently relaxes. Fose stripes while retaining buff. And now I see that it has little or no back spot. Certainly no red polka dot. Perhaps a faint small smudge of dark in same area — doubtless an internal organ showing through.

Then O comes to rest only a few inches from OO. No reaction by either animal.

Now OO is showing Arm stripe without Fin stripe.

Everything very placid 8:55 am. Leaving

We go out in the boat later this morning. To Wreckthapel again. Start on inner side and then work along outer side. 10:15 am. - 1:45 pm. Weather is good. Tide is high.

The results were not so good, however. We did get occasional glimpses of sepiots from time to time. All more or less close inshore. Usually over

Ceph., July 22, 1981, III.

(144)

sand and/or coral. But all the animals were spooky and impossible to work on. (NOTE: most of this coast looks absolutely pristine. I doubt if the squids are hunted intensively by human beings at these particular sites. The shyness of the animals must be due to other kinds of predation.)

The most interesting observation was in a sheltered bay at 11:20. A caught a glimpse of a group of Sepiots. Over sand and coral. 2 of the inds were large. And both showed Mudriff Barn. (This may be the first "real" sign of courtship or other sexual behavior that we have seen at Palau this trip.) SAN.

Later on we investigated another sheltered bay. Very gradual slope leading up to a "rock slab" beach. The physical environment looked ideal for Oscars (a sort of natural boat ramp). But we did not find any Oscars, although we looked carefully for quite a long time. Why? I did notice that there were lots of substantial sardines around. Plus one small Barracuda. And, in the shallow part of the shallows, a mass of small, long-jawed halfbeaks. (Even though they were small, all or most of the halfbeaks were at least 3 to 4 times as long as OO.) Any Oscars in this area would suffer great risks of predation (and probably intense competition too).

On our way back, we stop at the boat ramp of Horror Harbour. Tide is still low, but presumably coming in. Again, I fail to find Oscars. But I do notice that there are very few sardines (and only very small ones at that), and nothing larger and obviously predatory.

Back to lab 4:55 p.m. O swimming and feeding in colorless. OO attacked to wall, head up, in buffy.

OO first shows thick Ance and Fin stripes when I approach. Then goes Dark all over (at least on upper surface). Then subsides back to buffy with stripes. No central or red back spot. But there is a trace of a DM-like spot on one side. Confluent with the Fin stripe.

O continues feeding non-stop. Gradually approaches OO. Who goes slightly paler, approaching colorless, as usual.

O is also showing a marked tendency to feed and to hang out at the same end of the tank as OO. This is a change.

Leaving 5:10 p.m.

Go to look again 8:00 p.m. When I shine the light on the animals,

Ceph., July 22, 1981, IV.

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I find that they are both, O and OO, in Dark or semi-Dark. And both apparently swimming (if only as a result of disturbance).

This at least goes to show that O still has functional chromatophores.

Palau,

July 23, 1981

The Oscars are still alive 6:58 a.m. Both attached to wall near bottom. O in colorless. OO in buffy.

O starts swimming. Again in same end of tank as OO.
COMMENT: I have been thinking about OO's change from buffy to colorless when O comes very close. Could this be an "invitation" or "acceptance" signal. An indication of the absence of hostility. ???

When I move about brusquely, O often makes sudden fast retreats. Without color changes, except, occasionally trace of stripes. OO continues attached but shows strong Arm and Fin stripes (these are quite distinct but not absolutely straight in outline). Always in buffy. At least one, Fin stripe is expanded at center of body to form DM spots. And the 2 DM spots are connected across center of body by a distinct Midriff Bar. There also is a faint trace of another Bar further back.

Double DM
with Bars



6:23. I look up from my writing to find OO attached high on wall. In head-up and full Dark. What provoked this? Animal gradually relaxes over next few minutes.

OO does not seem to have red back spot today.

6:45. OO is hanging in buffy with stripes as usual. Then suddenly swims across tank, turning colorless, and starts to nibble vigorously. Then attaches in double DM with Bars and stripes. Dark arms are slightly flared.

Then feeds again in colorless.

O is startled by a movement of mine, and jets backward, inches without color change.

Ceph., July 23, 1981, II.

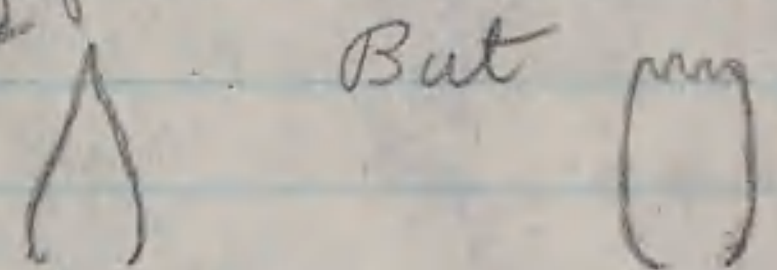
(76)

OO is still feeding vigorously in colorless (with only faint and brief flashes of buffy).

Then attaches in steady buffy again. With Arm Stripes. I also attaches in colorless, but not absolutely clear (a slight tinge of buffy is visible).

8:30 A takes many photos.

Then OO starts feeding again. Again going colorless or semi-colorless.

NOTE: Even when swimming normally, forward or backward, the arm bundle is always blunt, not pointed. Not But 

9:00 a.m. While I am putting food into tank, OO assumes a particularly dark Bar pattern (doubtless transitional to full Dark). Definitely 3-Bar. Midriff Bar dark and broad (DM, faint, is obscured). Rear Bar somewhat less extreme (although fins are dark chocolate brown). Third Bar is anterior, near front edge of mantle. It is the faintest of all.

NOTE: I think that Stripes persist, or are combined with, some or all Bar patterns.

Stopping observations 9:10 a.m.

Back to lab 10:30. O attached, arms up, in colorless. OO feeding vigorously in buffy and semi-buffy. The 2 inds. are not close together. Then O goes to feed, in colorless, at opposite end of the tank from OO. OO attaches. O continues to feed. No color changes.

NOTE: almost all attaches now are head-up, tail-down, arms raised. Raised arms sometimes slightly curved. An attached animal always faces away from the attachment surface.

OO has Arm Stripes but no Fin Stripes while attached.

Put in branch of coral 10:55, while both animals are resting in opposite end of tank. No one pays any obvious attention.

11:06. O is now resting attached laterally, slightly head-down, with arms raised, in colorless.

Then starts to move around

before. Then goes to feed other end tank. Apparently ignores coral. Then attaches itself to wall. Again laterally, slightly head-down. Arms slightly raised but not curved.

Perhaps the 2 inds. do have slight individual differences in preference for

Ceph., July 23, 1981, III.

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resting postures?

OO does a little swimming. Then feeding. Both in colorless. This must, I think, be a sign of increasing tameness and self-confidence. Feeding is all rubbing. Anchor seems to have quite disappeared. Was it only a nervous tic ???

OO goes buffy from time to time while feeding. I can't see the releasing stimuli.

Both inds. feeding actively now 11:45. Neither has approached the coral. They certainly are not curious! Presumably out of caution.

I finally does approach coral 11:50. Comes within an inch of several branches. Hovers HD in water column. Briefly extends tips of tentacles. (Are these chemosensory?) But no color change. And then goes back to rubbing from walls of tube.)

OO is attached in buffy again. But quite horizontally.

Arms certainly are slightly (not too slightly) spread (and curved inward) by both inds. during resting periods.

Everything very dull, everyone asleep. Going to leave 12:10 pm.

Walking toward town 12:35. Tide is going out. But wind is rather rough. Nothing of interest at front sea wall. Arrive boat ramp harbour 1:00 pm. Tide (still) much higher than on previous visits.

Quite a lot of small sandeels now. But nothing else of interest. Go on to area by plane ramp 1:25. Nothing. On to a small sea wall. Then back to boat ramp again. There is a big explosion among the sandeels a few yds away. Obviously there are at least some predatory fishes around.

A blue and black banded sea snake appears!

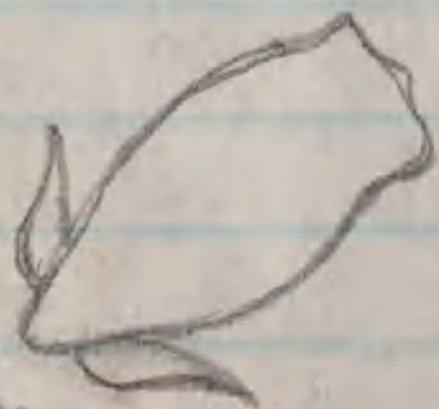
Then see 3 of the little squid-like fishes in tight group.

Water is getting rougher and sunshine is only intermittent. Packing up 2:15.

Back to lab 3:50 pm. Situation much as usual. O attached and feeding in colorless. O attached in semi-buffy with colorless arms.

Fin shape, when not beating, is:

In this connection, it may be worth noting that OO's fins are absolutely immobile now while it is attached to wall. Quite transparent.



5:15. Resting OO suddenly wakes up. Turns colorless. Starts to swim. Protrudes tentacles half way. Darts across tank and apparently catches prey in water. (Its eyes are open even when it is asleep!)

Ceph., July 23, 1981, IV.

(78)

NOTE: Arcadio finally found Sepiots today "Courtship", copulation, egg-laying - the whole bit. SAN.

Back at lab. Again I notice that arms are slightly spread and incurved in attached resting postures.

4:45. O is now attached to coral itself in light. I assume that the Dark is an indication of some anxiety at using a new substrate. → In Dark. Why? The coral

OO starts feeding again. Again goes semi-colorless. O, still attached, is getting lighter. OO attaches again, and goes bruffier again.

Still no trace of red back spot.

Stopping observations 5:15 p.m.

5:25 p.m. Bruce finds large group of Sepiots just at seawall. Difficult to see. But reproductive behavior in full swing. Lateral felves, Bilateral felves, "flares", Tawny (or Gold), extreme Darks, etc.

Could this outburst of behavior be due to the fact that Beebe has stopped fishing today ???

ADDITION: According to A, the animals that he observed here today were behaving like the lemoniana of Guam. I.E. this population probably is lemoniana too. Is the species widespread in the Indo-Malayan region?

Go back to look at Oscars for the last time 8:25 a.m. Find O attached, in Dark, to white part of beer can. OO, on the other hand, is attached to coral. At least by the time that I find it in light, it is bruffy. Both mols break-up with arms raised.

No sign of luminescence.

Palau,

July 24, 1981

Out to seawall 7:00 a.m. Tide low. Very calm.

Find group of 23 Sepiots immediately. Same place as last night. In diagonal line. Mols graded in size. Large on one end. Ranging down to small medium at other end. All in semi-Dark. No WS or PA or WHL. Just swimming back and forth, first forward and then backward.

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Some indication of 2 sub-groups, larger inds. vs. smaller inds.
also indications of at least 1 pair.

Larger inds. move off, leave smaller behind 7:06

Find 11 larger in inlet. Several inds. are lighter than Dark, with broad diffuse stripe down center of back. Not a typical WS but probably related. Perhaps a preliminary indication of possible courtship, but the animals are swimming calmly enough now 7:15.

Then find whole group of approximately 23 reunited in front of seawall. This does not include the inlet animals. I.E. there probably are at least 35 inds. in the general area. All the animals are near surface as usual.

Inlet animals behaving as before. Perhaps some trace of unritualized Roaching among the lighter inds. One shows RL (or perhaps a scar?)

Every once in a while, an ind. advances as if preparing to feed. But I haven't seen any strikes yet 7:27.

All inds. are going pale - wh with trace(s) of diffuse WS now.

Wall animals still in Dark. One ind. goes slightly lighter, retreats before another with conspicuous, rather thick, BB. Group on the whole scattered and relaxed. Then more active. One ind. Pales front of arms with extreme Y. Again notice one ind. in only semi-Dark with conspicuous BB.

Sub division into 2 sub-groups still evident.

Another ind. with conspicuous Y and RL (definite). NOTE: Y in these circumstances must be intraspecific.

Brief retreat by whole group in semi-Pale.

One ind. with both BB and Y simultaneously.

One shows semi-Lateral Silver swimming backward toward another. Both are large. Then relaxes. Another rather smaller large does first Lateral then Bilateral Silver swimming backward toward another. The latter is in Dark and does brief Flare. Another, in Dark, does extreme Flare, in Dark, when another ind. also in Dark swims above it.

Then Flares must be ritualized. I suppose that they should be considered to be low to moderate intensity spreads.

Animals in inlet as before 7:53. One trace of Lateral Silver by a large. Are Lateral Silver type patterns more common in this species than in

sepioidea?

I take a break 8:00 a.m. Back to seawall 8:10. Sepiots still there. Calm.

One large "flashies" conspicuous narrow WS.

Suddenly all retreat without changing color.

8:17. Andree sees one of the inlet Sepiots take a sardine.

NOTE: Marcus says that there is at least 1 Cuttlefish farther down wall.

One inlet large, rather isolated, goes into pale-ish Ored with diffuse WS and conspicuous White Fins as it swims backward toward other members of the group.

Several other inds. go lighter than Dark from time to time. All these lighter colorations show a tendency toward Tawney.

One ind., very large, in semi-tawney, shows Flare, with white arms with black spots. I.E. a trace of Z. Perhaps as extreme as it ever gets in this species?

Back to seawall. One medium goes goes rather bright Tawney all over.

Well! Well! Well! 8:30. Suddenly a rather large cuttle (presumably at least half grown) appears. Swims in a straight line, rather high in water column (which is still low) within 2 ft of Sepiot group. Cuttle is rather purplish "Ored" on side of body toward seawall (and me), perhaps slightly darker on side toward squids. The cuttle seems to pay absolutely no attention to the squids. The squids are all in Dark at the time. They all turn to face the cuttle as it goes by. But absolutely no color change. No retreat either. (One fairly small ind. even advances a few inches toward cuttle. Curious?)

The cuttle looked like a battleship by comparison with the squids!

One Sepiot, rather isolated, flashes Tawney. Why? Reaction to passing fishes?

Largest ind. of all is at end of line. And not obviously paired.

Inlet squids as before 8:45. Very placid.

Back to seawall. (Again) one ind. flashes narrow WS, only on rear part of body. I can't see either stimulus or effect.

NOTE: all these animals are remarkably sedentary. Especially as they certainly are not engaged in egg-laying now.

The 2 sub-groups of the wall animals seem to be separated now. Or, rather, the sub-group of larvae has disappeared. And I see many large blobs of ink where they used to be. Unfortunately, I didn't see the incident.

Taking a break 9:00 a.m.

Ceph., July 24, 1981, IV

(87)

Go to look at Oscars 9:50 a.m. They seem to be fine. Attached opposite walls. O in Dark, arms curved down. OO in Buff.

OO swims and feeds in colorless. Then re-attaches to wall in Buff. O goes over to coral, and attaches in semi-Dark. (Note: this is not particularly twing - rather different from Buff of OO - described "granulated").

Spend my time changing water, giving food, and sketching.
Finish last of chores 11:25. Both animals begin to feed vigorously.

Muzzling (only arms used, not tentacles). Also in water column (again apparently using only arms). Then they bump into one another. Accidentally? Stimulated by OO? O immediately retreats and attaches itself to wall in colorless. OO continues feeding in semi-colorless with distinct dark smudge center of back near part of body.

Is this indication of Median Strake? I think so. Is Median Strake relatively aggressive???

NOTE: No trace of red back spot at any time today.

Taking a break 11:35 a.m.

Sept group is still at sea wall. Still Dark and dull.

Back to Lab 12:55 p.m. O swimming in colorless. OO attached in Buff. Then OO swims around in semi-colorless. With short Anchor. Very dull. Everyone back to sleep again.

Then OO swims in semi-Buff. And muzzles. O swims in colorless. Both jiggling. OO loses semi-anchor. Then resumes it again. This does look sensory or exploratory.

OO attaches to coral in colorless. Under projecting knob. Darts away in Buff when I move coral. Comes back. Reattaches in colorless. Darts away in Buff again when I move coral again. Then goes hunting in semi-colorless. Muzzles from bottom (Buff).

Leaving 1:48 p.m.

Going to look for Oscars by old ferry landing 3:15 p.m. Tide is going out. Nice shallow coral rubble beaches. But current (especially from under bridge) is strong.

Stop 4:15 p.m. as light is getting difficult.

NOTE: A went to Pelelie today. Covered a great variety of habitats, including Turtle Grass, without seeing a single squid. The distribution of Lusomana certainly is difficult to figure out (at least on a small scale).

Ceph., July 24, 1981, V.

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NOTE: We must not forget acknowledgements. Including Birkeland, Franke Cushing, A. Malilay, C. Gondeaud, Noah Idichong.

Palau,
July 23, 1981

Both Oscars still alive and apparently well in tanks 7:00 a.m.

NOTE: We have been using Fritz-Zyme #2 "salt-water helper", from Fritz Chemical Co. P.O. Drawer 17040, Dallas, Texas 75217, to control ammonia in the water (it converts ammonia to nitrite - algae eventually convert nitrite to nitrate).

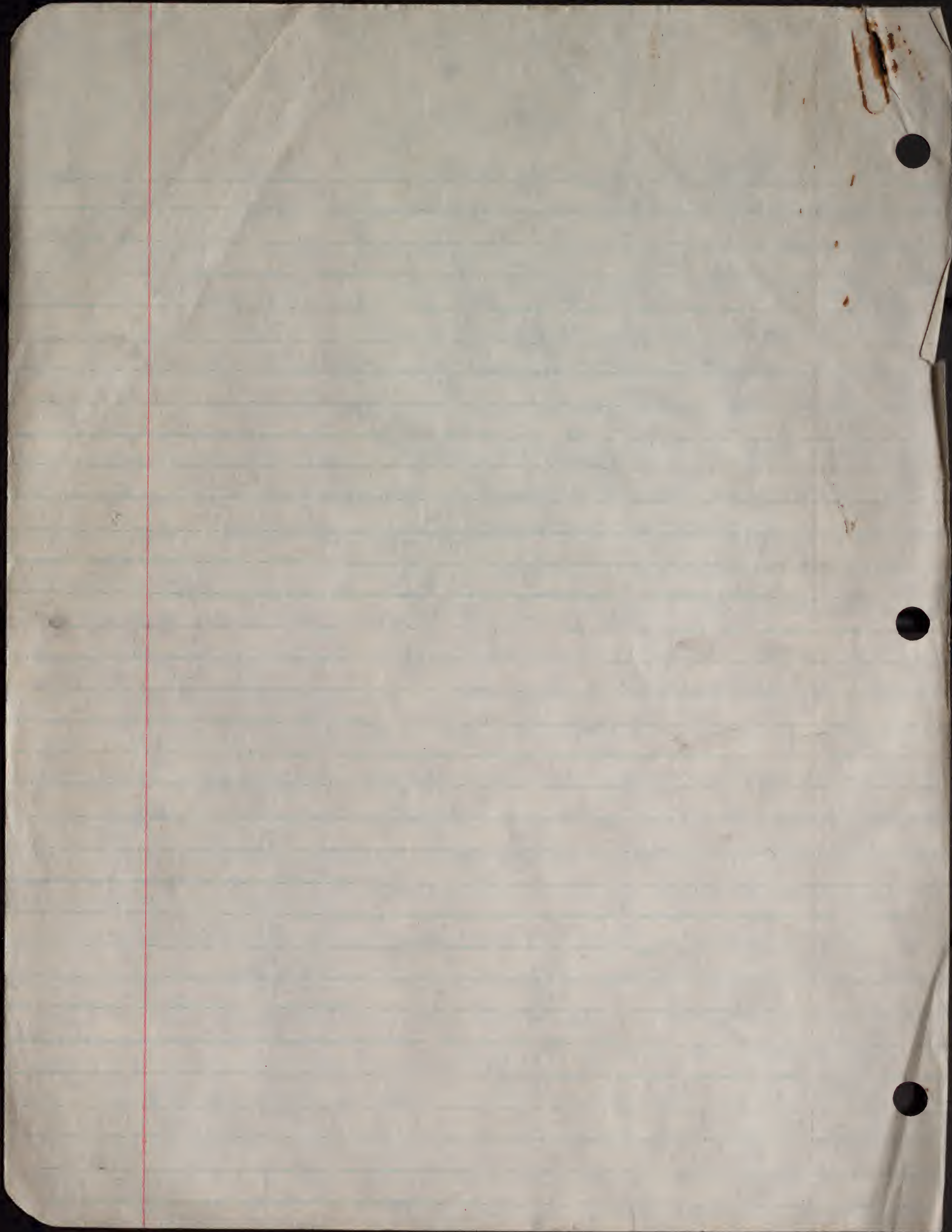
OO darts away in full dark when A drops pipe in tank.

No great burst of activity when food is put in 7:20. OO attached to coral in semi-dark. O attached to wall in very faint trace of dark.

OO has something black attached to base of arm mass. Could this indicate that mass is sticky?

Everyone still sound asleep 8:05 OO lurking beneath mob of coral. Only head and arms visible from above.

Stopping 8:25 a.m.



Cephalopoda

(82)
B
Negros,
Philippines,
November 10, 1981

Arcadio has been here for approximately a week now. He has seen some Cuttles and some Sepiots which look like the forms of Guam and Palau. Nothing very exciting so far.

Today we try a "new" area. The beach of Jilicon in the township of San Jose, Negros Oriental. Weather is sunny and windy.

We go into water 11:08 a.m. Arcadio and Cairo swim out into deeper and more open water in the general direction of Cebu. I stay behind in the shallows.

I explore quite a bit of shore line, sand and rock, moderate slope, and also explore dock piling, floating debris, and off shore posts of coco palm trunks (for some sort of fishing net?). Looking for O's and Sepiols. Unfortunately water is murky, due to wind. I finally give up 12:04 p.m., without having seen anything of interest.

A + C make 2 trips to their (same) deep water site. They don't see anything on the first trip. On the second, however, they find a single Cuttle (perhaps a ♂ waiting for a ♀?). They also observe an encounter between the cuttle and a group of Sepiots. Sepiots apparently "curious". The Cuttle ignores them. SAN

NOTES: Apparently the O and OO individuals died last July, the day that I left Palau. The specimens were given to a guard at the US NMNH on a Sunday, for delivery to Roper.

Early this morning, we went to the fish market. Bought examples of at least 2 spp. of squid (Sepioteuthis and ? Loligo). These will also be sent to Roper.

ADDITION: Arcadio saw some other squid in Hawaii on his way here. Again SAN

Cephalopoda

Negros
November 11, 1981

Go to a new area today. South of Dumaguete City (yesterday we went north). A beach called Ciattron in the township of Malabuhon.

Do lots of swimming several hundred m. off shore, without seeing anything but ink. Then A + C do a dive. See 2 Cuttles and some Sepiots. Little or nothing in the way of interspecific reaction. A gets film sequence of one Cuttle. SAN.

NOTE: A thinks that Cuttles may be mimicking pufferfishes.

COMMENT: It would appear that the local Cuttles here and at Palau are little gregarious, during the daytime, apart from reproduction. Why? Of course, the Cuttles probably do not need to cooperate in hunting. Perhaps they also are so large that they are immune to most predators? Or does their type of crypsis preclude aggregations?

NOTE: A also found clutch of Cuttle eggs. In relatively shallow (20 ft) water. This seems to be shallow for Loliginidae.

Negros,
November 12, 1981

This morning we go to a place called Lag-it, in the Okot area, in the district of Bais City (and on the island of Pulong Dako ~~is~~ connected with the mainland of Negros only by a bridge over a mangrove swamp or creek).

Cario says that he saw very small squids (or cuttlefish) here in very shallow waters (a few inches to 1-2 ft) in the mangrove near here some time ago. We think of O or Sepioida or even young Loliginuncula (the genus is supposed to be pantropical).

Arrive 7:45 a.m. C immediately begins to look for the animals. No luck (water is quite murky). Then we go over to the opposite side of a small bay. C looks from 10:15 a.m. to 12:15 p.m. Again unsuccessfully.

In the meantime we talk (via Lawton Alcala) with a local

woman who seems to be knowledgeable and intelligent.

She says that that the small animals usually found in the mangrove have a "skeleton". This would suggest that they might be infantile or juvenile Sepia. As far as I know, such habitat preferences have not yet been reported for the young of any species of the genus. She also mentions that such animals are often left "stranded" in pools after the retreat of high tide. Either as single inds. or as small groups of 2-3 inds.

A few minutes later, the same woman adds that there is a second type of small cephalopod - apparently a squid - which is found along mangrove, along other kinds of coast, and (?) farther out in the bay. These seem to have a special name. ? "Talostoo" ?

In any case, both types are caught by the local fishermen. We will go to the local market early in the morning the day after tomorrow.

NOTE: Cairo's "real" name is DIOSCORO INNOCENCIO.

Migres,
November 14, 1981

7:15 a.m. Chuk Bais City market. Squids not arrived yet.

Go on to village that we visited the day before yesterday. Nothing on sale now.

Back to Bais City market. Some Sepiots. Then we buy, in quick succession, one small Sepioida-type, one rather small Sepia (which might, just conceivably, be different from the large form that A has been photographing) and one rather small Loligo-type. All for Roper.

NOTE: these animals probably were caught by seining in either North or South Bais Bay.

Then Lawton gets another small Sepioida-type individual.
We leave 9:40 a.m.

Then go on to Jangay market 10:05. Lots of Sepiots but nothing else.

NOTE: the Tagalog word for squids (and cuttles?) is pronounced "Nokoo" but seems to be spelled NVAOS.

Cephalopoda

Guam,
November 19, 1981

85

Start out rather late this morning. Weather is peculiar. Very gray and hazy. Rather like the outskirts of a typhoon, or at least an approaching tropical storm. But almost no wind.

9:30 a.m. Small enclosed channel by Piti power plant. We walk along sides. No squid visible. But then we see a large octopus in the middle of the channel. Swimming backward, with arms in 2 "V-bundles" trailing. Apparently more or less dark all over. A says that this octopus is being accompanied by 2 "pipefish". Coincidence? In any case, the animal moves several m. and then settles down on bottom. Still apparently "dark" or "dark mottled". Then it "flashes" some color changes. Lighter patches. On arms? As a reaction to a nearby goatfish ???

A goes into water to try to photo. But octopus disappears immediately. Probably into hole.

R swims back and forth along channel. Certainly no sepiots or cuttles.

10:10 a.m. I am walking along edge. Suddenly see tiny animal in 1"-3" of water over rocky ledge at shore. This might well be an O. The animal seems to be in medium dark "buffy" or "Ord" (+?). Swimming rather energetically but erratically back and forth. No very obvious feeding movements. Unfortunately, by the time that I can get my (reading) glasses on, the animal has disappeared. Gone out into the channel, and/or under the ledge, I think.

Then we go on to Gun Beach (Jumour Bay region). Start into the water. Tony runs into a rather large octopus almost immediately. It inks copiously. And then clamps down on a mottled reddish rock. It assumes a mottled reddish coloration (largely white flecks against a "flushed" background) at the same time. It holds its ground even when Tony and I approach within a foot or so. Finally, Tony picks it, and it slides away into a crevice. With little or no color change.

Then A and T go swimming outside reef. I cannot follow, as my mask has collapsed. They see only one sepiot. Finally start back 12:30 p.m. On the way in, T sees octopus in more or less same place as before. But it disappears before A can get back to photo.

Cephalopoda, Nov. 19, 1981, II,

(86)

COMMENT: Both the octopi seen today were remarkably bold and exposed for the daytime. Is this because light is so dull today?

In any case, there is pouring rain - and rumors of typhoon by early afternoon. And then some clearing up in the evening!

Palau,
November 22, 1981

Back at the MMDC on Malakal.

Weather has been bad recently (tropical storm Irma on Guam, heavy rain here last night). Partly sunny early this morning. But tide is high at dawn. Also windy. Impossible to see anything from breakwater.

Starting out toward harbor, to look for O's, 9:00 a.m.

Some trouble getting to ramp in Malakal boat ramp. Everything locked on Sunday. Finally arrive 9:40. Sunny. Tide quite far down now. But considerable swell. As usual, a fair amount of debris.

No squid visible at boat ramp immediately. Go on to sea plane ramp. Again nothing visible.

A few sardines around.

Probably one brief glimpse of an O (in Ord) 10:45 a.m. But very debris. Stopping 11:20 a.m. Tide coming in.

Palau,
November 23, 1981

Going out in same direction this morning. Water is a little calmer now. But there may be rain later.

Start out 7:30 a.m. Try to work along shore, but I find that it is too rough. Finally arrive boat ramp 7:50. Here it is much rougher than yesterday. (Wind has shifted from W to S.) And the water is filthy; mud, debris, even an oil slick. Tide is only half down.

The boat ramp is hardly better.

Going off to town 8:20 a.m.

Cephalopoda, Nov. 23, 1981, II

(87)

Starting off again 7:40 am. It now sunny. Wind moderate by MMDC. Arrive boat ramp 10:00 am. Tide is rather far down, but not all the way.

Perhaps - just perhaps - one brief glimpse of an *O* almost immediately. In 6" of water over concrete. Darkish at first; then turns quickly paler or transparent as it retreats into deeper water.

10:30 The plane ramp is even worse than it was earlier this morning.

NOTE: I have just talked to the local Meteorological Station. They expect strong gusts (from Guam?) this afternoon. It is interesting that *O*'s seem to be less common here than in July, in spite of the fact that the weather is windier now. This might suggest that the animals observed in July were not "blown off course".

Tide is quite low 10:45.

This is ridiculous. I am leaving 10:55 am.

Go swimming along lab breakwater 3:35 - 4:05 pm. Water is murky. I don't see a thing.

Palau,
November 24, 1981

Out to MMDC breakwater 7:30 am. Sunny. Little wind. Sea is calm and clear. But no squid by 8:00.

Try again 8:35 - 9:05. Still nothing pertinent.

NOTE: According to Becky, the squids have been around by the sea wall, at least from time to time, recently.

Going on to harbor. Arrive boat ramp 11:00 am. Still sunny. Incredibly hot. Water is calm. Tide is moderately down. (Low tide is 12:18 pm. today)

Working both ramps alternately. Still quite a lot of "gook" in the water.

But no sign of squid. Leaving 12:15 pm.

4:20 pm. Back to harbor for one last look. Tide is high now. Water calm but with lots of debris.

4:40. Back of plane ramp. Flooded gravel beach. See small reddish, rather squid shaped object in water. Dooop with dip net. And the animal or object suddenly changes color and disappears. What in the world was it?

Rain coming 4:45. I stop work.

NOTE: Malakal Harbor seems to face slightly W of S. Bordered by Rock Islands on one side. Port installations and more Rock Islands on the other side. And open mouth of the outer reef (presumably cut by ship channel). This would suggest that the O's probably do not come from mangrove.

Guam,
November 26, 1981

Sunny but quite windy today. We go straight to Piti channel (the main, "outer", channel in the lagoon). This is calmer than most areas.

We go into water 9:00 a.m. A found a clutch of Sepiot eggs here a few days ago. Under a sheet of corrugated iron on sand and rubble bottom. In perhaps 10-15 ft. of water. SAN. We check the clutch again today. It is still there.

A also found a pair of Sepiots in area a day or two after the clutch was laid. They looked as if they might have been "guarding". But they seem to be gone today.

We swim around for a while. Tony sees group of what he thinks are very small squids. 20-25 inds. Rather high in 5-10 ft. of water. If Tony's identification is correct, these probably are more likely to be young Sepiots than O's. We try to catch one of these animals, but we fail.

Out of water 9:30.

Kanokohe
November 28, 1981

The local "Sepiola" is a species of Euprymna. Apparently common. (Unfortunately) nocturnal. Already being studied. Sand-burying behavior. By student called Andree Novicki (spelling?). We will go looking for it tomorrow night, if the weather improves (apparently it has been blowing hard for a week).

Cephalopoda

Kauai, Hawaii
November 29, 1981

The specific name of the Euprymna here probably is scopeles.

We started looking for the animals at 7:30 p.m. In the shallows by the mainland dock for the marine station. 8"-3' of water. Sandy bottom. With rocks and/or small clumps of coral in some areas. Wind and current (from open sea) strong. We found approximately 25 animals within 1 hr 30 mins.

All the inds. captured were near surface. All essentially alone. Sometimes light, sometimes dark. Probably (?) usually light (colorless?) before entering beams of light.

Apparently drifting with current. Appearance probably deceptive to some extent. No attempt at mimicry. (Nothing to mimic.)

One ind. certainly retracted in Pale and/or Colorless.

Some Inking on captures.

One ind. (not seen by me) apparently flashed greenish (bacterial - see Nicols, also Harvey) light on being transferred from net to bucket.

In buckets, inds. varied from Pale to Dark. Usually settling down on bottom in Dark.

Later on, obviously flashing from Pale to Dark and back again, according to various stages of alarm.

Still later, when transferred to tanks in lab, many inds. went a medium brown when settled against medium brown substrate.

All inds. settle against substrate in any case.

Probably very much like Sepiella of Senegal.

Kauai, Hawaii
November 30, 1981

All or most of the little Euprymnas ("Eup's") seem to have survived the night. Most of them looking pretty good when we arrive 10:00 a.m.

I kept 15 inds. last night. (The rest went to Andrea)

They are kept in two large tanks (2' x 4'?). 5 small inds. in

one tank with only 3" of water. 2 small inds. and 8 larger ones in tank with 4"-5" of water. Both tanks aerated, with continuously flowing water. Tanks are made of wood. There is a miscellany of pipes, rocks, clumps of dead coral on bottom to provide some shelter.

Smallest inds. are hardly longer than O's, although they are considerably plumper. Largest inds. are considerably more than twice as large.

All or most of the inds. are just sitting on the bottom. I am not sure that any are actually inside the tubes or under rocks. Scattered apparently at random. Never very close together. Usually at least several inches apart.

They are sitting with arms tucked in. Tucked in more or less straight down (and back under body), I think. Not swept to the side like the Sepioida of Senegal.

Most of the inds. are medium brown, more or less the color of bottom wood. One small is consistently in dark. This may be a sign of damage or distress. Another small is often dark without obvious cause.

NOTE: The medium brown is very cryptic in these circumstances. And presumably assumed "purpurfully." But presumably the animals do not have to bother to be cryptic most of the time, during the day, in the wild. According to Andrea, they bury themselves in the sand with only their eyes showing.

The inds. do show a tendency to line up along the walls. Tails to the wall, head facing outward. Obviously just looking around warily. As far as I can tell, however, they do not press up to or against the walls like the O's of Palau. No real "attachment".

We put some food (collected from beach, apparently amphipods) in both tanks ca 10:30 a.m. No immediate response.

Some animals do move around spontaneously. Slowly. Just above substrate. Never very far at a time. Arms apparently tucked in as when resting.

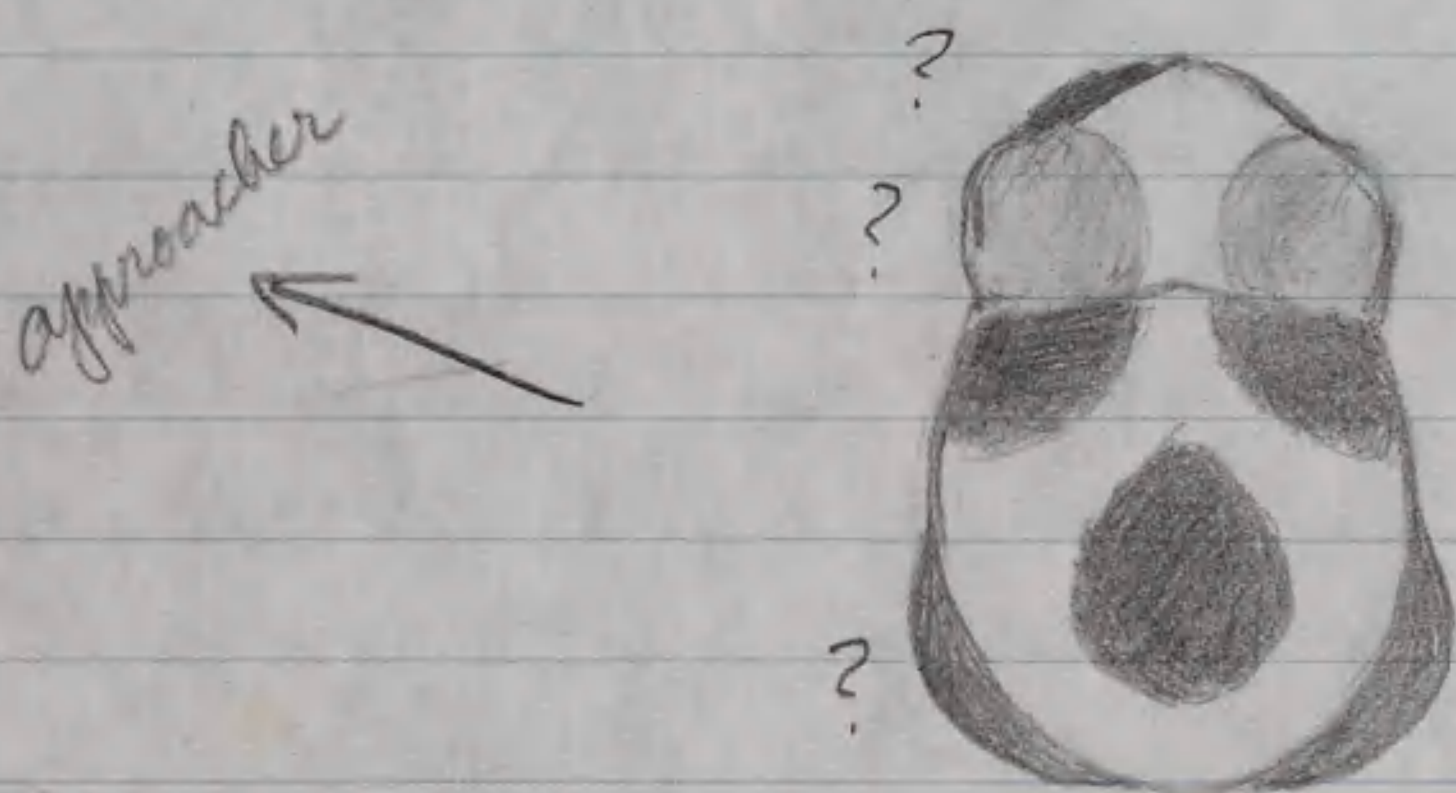
Ca 11:15 one small ind. moves its arms a little while swimming. This could, conceivably, be feeding. (But the animals are so small that it is very difficult to see details.)

I have intentionally disturbed 5 or 6 animals at irregular intervals. Their reactions have been rather interesting. They go dark all over when my finger gets close. (Presumably this dark usually would not be visible in the

fuld). But they usually do not retreat until my finger is almost or actually touching them. Then they retreat still in Dark. One particularly vigorous retreat by a rather large ind. was preceded by Inking. But even this ind. remained Dark throughout the incident. No trace of Pale. (Why? Could I have been mistaken last night? Or is Pale particularly high intensity in this species?)

The blob of ink seemed to me to be unusually coherent. And very much the same size as the animal. A very good "dummy" indeed.

Once, when I moved the detector, I induced one relatively large ind. to move closer to another relatively large ind. When the approacher was about 3" away, the approached suddenly adopted a very distinctive color pattern. I shall call this pattern "Dice". More or less comme ça:



Three very distinct blackish spots on back. One central. Two anterior, on either side front edge of mantle (actually just behind eyes.)

Plus blackish on or near fins. Perhaps a Fin Stripe or BB type pattern. More probably, I think a wholly Dark Fin. (NOTE: the fin shape shown in drawing is not to be relied on. Real fin shape is actually very difficult to see.)

Plus conspicuous Dark on arms, at least on side nearest approacher. Possibly just an extreme Arm Stripe (NOTE: this may not be visible from directly above as shown in the sketch.)

The pupil of the eye was also conspicuous when seen from the side.

This pattern may have been accompanied by a trace of Dark Eyebrows. But this component was not conspicuous.

This pattern might well be equivalent or related to the DM of other species. Perhaps the two anterior spots are even homologous.

In any case, the Dice seemed to be effectively "off putting". The approacher

stopped and settled down $1\frac{1}{2}$ " - 2" from the approached

The approacher was in medium brown throughout. The approached gradually lost the Dice, resumed medium brown, after the approacher settled.

Several inds. show a tendency to go Dark all over when I shine a bright flashlight on them. (The general illumination in this room is less than dazzling. And the tanks are slightly shaded.)

One ind - the approached in the incident described above - responds to the flashlight by turning semi-Dark all over the top of the top of the head (including eyebrows) and showing the center spot of the Dice also in semi-Dark form. (The chromatophores are quite visible in semi-Dark. A freckle effect.)

Everything quiet 12:45 p.m. But several resting inds. show trace of full Dice (faint imprints) without obvious cause. Other resting inds. are still just pure light or medium brown.

Now I get a rather better view of a large ind. in a rather strong "semi-Dice". The dark coloration in or near the fins does seem to be a Fin Stripe on the body. Fin itself seems to be quite colorless.



And all the arms are all Dark, sharply marked off from lighter color of "forehead".

NOTE: Apparently Dick Young has been working on the chromatophores of this species. And Eric's assistant has seen them feeding on "little red shrimp". Presumably in the daytime. Shooting with tentacles.

1:35. Now I see a resting large with well marked Fin Stripe with out "other" or "real" Dice components.

Two smalls resting 2" apart. One very light. The other in Dice-y pattern. The latter suddenly swims away. Makes some active movements with arms. Feeding? In any case, turns completely Dark during movements. Then comes to rest and turns lighter.

One small has been hiding in white PVC tube. Suddenly comes shooting out. Possibly disturbed by flashlight. Quite light as it comes out. Settles on wood and turns very Dark. Then starts to move about. Moving arms, but

not tentacles. Trying to feed on something ??? Certainly not an amphipod.

2:30 pm. Find 2 rather large inds. only 1" apart under overhanging bulge of rock. Both in quite normal relaxed coloration.

Spacing does seem to be random socially if not topographically.

2:45. Try a little experiment. Take one of the larger out and put it in finger bowl. Does not change "relaxed" dorsal color when I first chase, even touch, it. But it may flash light glauc (underneath rear). Then turns very dark and hiles when I get it into net. Turns much lighter when put into bowl. But not really complete Pale. Freckled on back and head. General effect light brown. Must be perfectly cryptic over sand. Arms are stretched out in front. But tentacles not very much longer than other arms. All the arms are completely colorless — or, rather, white. Animal keeps bumping against wall in effort to get away. Also develops broad fin stripe. And traces of anterior Dice spots. This gives the effect of a broad dark band all around body.



The chromatophores are less dense, or smaller, or less expanded above the fin stripe than at the center of the back. Thus there is an ill-defined light (yellowish) stripe above the fin stripe. There is no trace of Dark Eyebrows. Or any real center spot.

Several times the animal shoots jets of water out of bowl. Apparently aiming at me.

Anterior spots soon disappear. Fin stripe gets gradually fainter. Animal folds arms underneath. They become yellowish freckled at same time. More or less like back. And they are splayed out in 2 bundles, like Sepiola.

This continues for some time. Animal gradually relaxes a little. Still generally freckled. But arms go white again. Held in various positions. Folded underneath, with or without splay. Also stretched out in front, in variable contorted patterns, from time to time.

Put the animal back in tank 3:00 pm.

COMMENTS: I suppose that the "freckled" is the *Ord* of the species. And perhaps the species carries a "complete" Pale. The "white arms" are only a partial Pale. Perhaps "obsolescent" ??

The species certainly is less visibly timid than any cephalopod I have

ever seen. Presumably this is correlated with the sand-burying habit.

Everything very quiet indeed 3:25. Certainly no sign of an evening "awakening". Of course.

Still no trace of activity 4:30 p.m. I start to pack up.

Kaneohe,
December 1, 1981

Arrive back at lab 9:00 a.m.

Find one small dead in shallow tank. But the other 4 smalls in same tank are still alive. And there are at least 8 inds. still alive in the other tank.

Unfortunately 3 out of the 4 remaining in the shallow tank are more or less Dark. This may be a bad sign.

We put in lots of brine shrimp. According to John Shear (Duke Young's student), these are not the kind of shrimp that the Eups like. Certainly these animals do not seem to like them. The small Eups simply move out of the shrimp's way. Retreating with little or no color change.

Some time later, we notice that many of the Eups (but not all) are literally covered by the brine shrimp. It looks as if the shrimp are literally stuck to the Eups. Are these cephs covered with sticky mucus in some cases ???

Anyhow, we try remedial measures immediately. Set up another tank (approx. 20 ft long), with patches of very light colored sand at one end, and transfer all the surviving Eups (14 inds.) to it.

Several inds. go Dark all over when being chased by net. At least 2 of these inds. also eject ink. Again I notice that ink is particularly cohesive, forming a blob of approximately same size as the ejecting animal. (Blob also moves about quite actively in these tanks with their dividers and tubes of incoming water.) Other inds. go semi-Dark, and/or show Fin Stripes (often or usually continued forward by traces of anterior spots of the semi-Dice type.)

When released in the new tank, all the Eups except one settled on bottom immediately. The exception was a particularly vigorous large, which swam away from me actively. (Obviously it could see me clearly). All the inds. settled on the sand, or soon moved to a sandy area.

The settled inds. retained the color (Dark or what have you) they had assumed before hand for some seconds or minutes after settling. But they all, sooner or later, assumed the color of the sand. Much lighter than the medium brown favored in the previous wood-lined tanks. Very finely mottled, again just like the sand. At first I thought that this color was due to the fact that they had become covered by the sand itself - presumably adhering to the mucus. But the change, in all or most cases, occurred before any of the inds. began to actually bury itself (see below). So I suppose that the change was a real alteration of the color (and perhaps the texture ???) of the skin. Wonderfully cryptic.

This is a species that has specialized in crypsis.

Every once in a while, I would stick a finger at a settled Eup. This would induce retreat. Obviously very reluctant and/or sluggish retreat in most cases. Sometimes without color change. Sometimes with a change to semi-Dark. Sometimes with Fin Stripe + partial anterior spots (I shall call this combination "Ring". The active large ind. retreated in a "freckled" pattern like the one seen yesterday. This Freckle obviously ritualized as such. Very different from the cryptic sand color. More yellowish. And the spots - the actual freckles - are much larger, darker, more sharply defined.

I think that the Freckle of this ind. was accompanied by at least a trace of Fin Stripe or Ring.

The Freckle presumably is at least moderately high intensity. Perhaps with relatively less alarm than full Dark ????


Several inds. retreated briefly in the full cryptic sand coloration above but with very dark, almost black, arms.

All inds. usually swim with arms pointed down. Usually also tucked backward. I could not tell if this was a distinctively ritualized E or not. (Perhaps the species always swims in this posture when it is not proceeding at full speed?) Thus the Dark Arm pattern combined with cryptic sand coloration was hardly visible except from the front. Was it disruptive? And/or was it an expression of high intensity Dark which had to be masked by crypsis to view from above.)

All these patterns seem to be primarily or exclusively interspecific anti-predator devices.

It may be significant that there was little or no trace of the full Dice during any of this catching and chasing. The full Dice may be intraspecific. Throat.

I suppose that the center spot of the full Dice may be strictly homologous with the "dark dorsal shield" and similar patterns of (other) squids.

After some seconds or minutes after settling, and after having assumed the sand coloration, all the inds. began to bury themselves. This began with strong, almost convulsive, backward (or backward and downward) lunges or pushes of the body. At (not entirely regular) intervals of a few seconds. Lunges usually continued until almost whole of body embedded in sand. Only top of head, eyes, and (at least sometimes) upper front part of mantle remained exposed. Then the animals began to throw sand on top of themselves. Using tentacles. Tentacles spread wide midline.  Then brought together or toward either in front

or backward

Pushing and flinging sand as they go.

The final result was remarkable. The animals seemed to disappear completely. Even the eyes seem to go. Either the eyes are really buried. Or they are partly closed somehow, so that the pupils appear as nothing more than tiny specks, indistinguishable from the sand.

Do these animals have eyelids ???

After all the animals were buried, we turned out the lights and left for lunch. Came back about an hour later. Peeking carefully with a flashlight, I find that two of the smaller inds. have emerged and are resting on the sand. Apparently still sand-colored.

REFERENCE. "The Biology of Marine Animals." By J. A. Colin Nicol. Published by Sir Isaac Pitman & Sons, Ltd. London. 1960. Illustration of (young) Euprymna morsei on p. 421. Diagram of light organ of Sepiella ligulata on p. 558.

Must also check E. N. Harvey "Bioluminescence". Academic Press. New York. 1952.

Fins of Euprymna shown in Nicol as:



The animals are left in the dark again.

When we look again, ca. 2:30, more of them have emerged. Some have moved far down the tank, away from wood. All apparently sitting rather than swimming. All show a tendency to turn darker in flash light.

Ca. 3:30. As before. Perhaps even more individuals out. But at least 2 large are still buried. When I disturb one, it used one tentacle to throw a little extra sand on top.

One large is sitting on wood in Truckle. Doesn't seem to be disturbed (but, of course, my light is shining on it). Could Truckle be the "Ord" of the species ??? If not, does the species have a real Ord in the Leptoteuthis sense.

3:45. I put a few Leander shrimp in tank. Everyone agrees that the Eups like them. But none launches to pursue my meager contribution while the flash light is on.

But then - about 15 mins. later - I see a large Eup resting on wood (in fact, the "Truckled" ind. noted above) - suddenly rush forward from the substrate, shoot its tentacles, and presumably catch some worthwhile prey. I observed this under very dim natural light. As far as I could tell, the animal captured its prey without any conspicuous change in coloration. Probably in Truckled throughout.

4:00. Bob Ross (one of the graduate students here - from Guam) produces many more Leander shrimps. 70+. We release them into the tanks. And then turn on the lights.

Some minutes later, I try to take a survey. At the far end of the tank are 4-5 small Eups resting on wood. Dark or semi-Dark now that light is on.

At the near end of tank, all the inds. that were on top of the sand bury themselves as soon as the light comes on.

4:10 One of the inds. at far end of tank suddenly floats up to near the surface. Quite small. Still in Dark or semi-Dark. In "HD" with arms curled below. My impression is that inds. of this species assume "HD" relatively frequently. Again when not moving rapidly.



or even



Some writhing of arms. Is this feeding?
On "cleaning"? On what?

Ca. 4:20 we turn the lights back on. There is a great burst of feeding. Presumably on the shrimps brought by Ross.

Most of the feeding is by more or less large inds. which had been buried in the sand beforehand. They lurk in the ground, suddenly launch themselves forward or forward and slightly upward. Then they shoot forward with the tentacles.

Now I see that these inds. do have sand glued to their backs. Small grains and even tiny snail shells. The effect is almost Ankylosaurus-like. A complete carapace on back. Also on top of head. (Of course, I can't see the undersurface of the animals.)

During the shooting, the tentacles seem to be more or less dark. Presumably an indication of anxiety. The animals may well be dark or semi-dark all over, underneath their carapaces.

The animals bury themselves in sand again between attacks. Same burying techniques as before. But usually the animals do not go completely under. Eyes and top of head definitely above surface.

Tentacles are colorless or sand-colored when they are used to gather and throw sand.

The carapaces are naturally cryptic. Of course this is cryptic against predators. It is also very cryptic against prey. Even a prey with good eyesight must be taken by surprise when a piece of the substrate suddenly launches forward in an attack.

Do the Eups feed this way in the daytime in the wild?

4:33. I put another pile of sand in the far end of tank. One of the smalls which has been in dark or semi-dark moves over and settles on sand. Gradually goes sand colored before burying itself. To my eyes, this coloration is almost or completely as cryptic as a real carapace.

What controls the formation or accumulation of a carapace? Is the secretion of mucus facultative or voluntary???

Just to recapitulate the situation as I know it now..... All the larges except one ind. (the Huddled ind.) have been buried in the sand.

All the ones that I have seen emerging to feed have had complete carapaces. There also is at least one small ind. buried. I have not seen it emerge yet. I suppose that it would have a carapace too. The rest of the smalls and one large are not, and probably have not been, buried. Of course, they do not have carapaces.

Interestingly enough, these exposed inds. do not have attached brine shrimps either. (And there are plenty of brine shrimps in this tank now.) I.E. they have not been secreting mucus. Why?

I do not think that the secretion of mucus can be "abnormal" or a sign of poor health. Some of the animals with carapaces have been feeding actively. (At least one ind. made 3-4 strikes in a period of 5 mins.) The "frickled large" without carapace has also fed at least once. And it looks bright and alert even when just resting.

It would appear that the species has alternative strategies.

NOTE: Even the accumulation of attached brine shrimps — whether voluntary or not on the part of the Eups — could well have been adaptive. The accumulated mass certainly disguised the shape of the animals.

One of the smalls outside the sandy areas leaves the bottom and swims up toward the surface. Hangs in a sort of head-down posture with arms curled and spread in a sort of E-like arrangement. In dark (still)



There does some writhing of arms. I have no idea if any of this is ritualized. But it is my impression that more or less head down postures are common in the species.

NOTE: One of the graduate students here, Frank Stanton (spelling?) looked in on the Eups last night. Found 2 of the large inds. clasping one another, front to front. According to Reese, Frank says that they showed "red spots" at the time. Perhaps frickles? Could this have been copulation? In any case, the animals did nothing more while the light was shining.

Wrong, see p. 107

Cephalopoda.

Kaneohe,
December 3, 1981

I talked to Andrea again yesterday.

Apparently the formation of carapaces of sand is quite typical of Eups.
See also abstract of paper by Lingley.

According to Andrea, the Eups also have a type of V pattern. Tentacles raised with tips curved down.

She also says that John Arnold thinks that the species is a seasonal breeder. October and March. See also his own paper of 1972 in the Veliger.

She has seen some of her Eups feeding in the daytime. Like the animals here the day before yesterday.

She says that the large ones here are approximately adult size. She also reminded me that we caught 3 of the large ones in quick succession in a limited area. Could this have been a courting party ???

Today we arrive at the lab ca 9:30 a.m. The tank seems fine. But not a single animal is visible. Presumably all buried. And quite thoroughly. I can't even see eyes or funnels. (Note: The lab is on an automatic light schedule 12 hrs on 12 hrs off. Changes at 6:00 a.m. and 6:00 p.m. Thus the animals have been exposed to light for several hours already.)

10:30. Find small ind. sitting on top sand. Complete carapace head and back. I poke it. It swims out and settles on wood. Of course, no color change visible. The animal just sits immobile. Moves a little when I break surface of water with magnifying glass. Sits again. Then moves around of its own volition. Usually only a few cm. at a time. One longer movement of 10 cm + Largely crabwise. Then sits again. Still on wood.

Then I put some brine shrimp in tank. The animal ignores them. But then it swims directly, head first, to patch of sand 20 cm. away. Sits. Then advances of few cm. Apparently seizes something very small on surface. Larva? Uses arms or unextended tentacles. Then retreats a few cm. Sits again.

Did the animal emerge because it was hungry? Was this spontaneous feeding?

In any case, it disappears while I am writing. But then I see what is probably


another, slightly larger, ind. 10 cm away. Head and upper back emerging from sand. No carapace on these parts. Skin medium brown. No freckles visible. The animal just sits and looks for some minutes. Then surfs back, uses tentacles to throw sand on head as usual.

After writing this, I return to find that the animal is no longer there. But there is an ind., probably same ind., on wood. In semi-dark. No carapace. Fairly conspicuous. Ind. gradually lightens a little until it matches wood. Sets. Then swims over to sand. No color change. Suddenly shoots out tentacles and apparently catches prey in water column. Then settles on sand. Still medium brown. Very conspicuous against light sand (but not in the environment as a whole - where there are many scattered spots of both light and dark).

Then the animal begins to feed more actively. 4 strikes and 1 abortive attack in the next 5-10 minutes. All at prey in the water column. I can't see the prey. Presumably very small. I can't tell if the strikes are successful or not.

Colors are characteristic and stereotyped.

Between attacks the animal remains more or less medium brown. And I see that it also has Ring, superimposed upon the brown. Anterior spot components are relatively large and conspicuous (Note. The Ring apparently is never quite complete; there always is a gap in front.)

The animal has something like a "Y"  Very diagrammatic. Two light yellow spots. At first I found it very difficult to determine precise location of these spots. Finally use magnifying glass. Then it appears that the spots are adjacent and medial to rear part of brow ridges. Perhaps extending a little bit up sides of ridges.



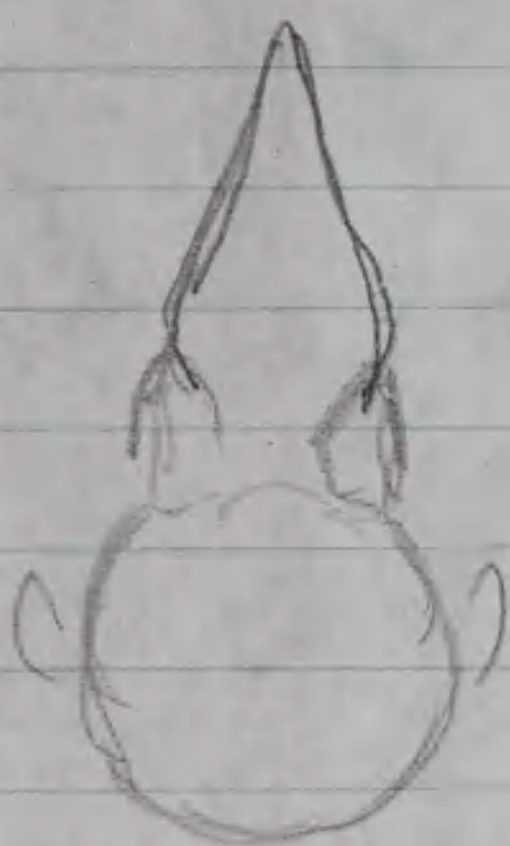
I am not sure of shape or position of fins.

Again very diagrammatic. Y spots may be too close together. (eyebrow ridges may be drawn too round). Individual melanophores (or clumps?) are visibly distinct, at least on back, when viewed close up. But this probably is not "real" freckles.

Fins seem to be quite transparent and colorless. This may be true in all Dark and Dark related patterns. (But the fins probably do have some melanophores. See photos in Arnold.)

Arm bundle is extended well before (some seconds) before actual strike. At the same time, or just as the strike begins, the animal turns noticeably lighter in color.

Commence



This presumably is a kind of Pale, but it is not nearly as exaggerated as the extreme Pales of other species.

Once the animal went first Pale and then Dark during strike.

Finally the animal makes another strike and seizes Leander. Shrimp is large. Probably $\frac{1}{3}$ - $\frac{1}{2}$ the length of the Eup. The latter hangs in water for some seconds after capture. More or less semi-Dark. Arms splayed out in irregular fashion. Moving. Sometimes contorted. Presumably grappling with shrimp. Then straightened out in tube. And now I can see that the shrimp is being held lengthwise, head out.

The shrimp is gradually sucked in and devoured from the tail up. As soon as it can, the Eup closes its arms over the front end (mouth parts) of the shrimp. Presumably breaking off mandibles at the same time.



I can't tell if the shrimp is paralyzed or struggling. Certainly turns or is turned partly sideways on several occasions. But it is always held very firmly indeed.

Finally the whole shrimp disappears from view within the arm bundle.

Then the Eup abruptly throws away (the presumably empty?) cephalothorax (or the front part thereof). The Eup rests on the (wooden) substrate for some seconds. Then swims, first tail first, then head first, to sand. Settles Buries as usual.

So the species is willing to feed in the daytime even when not starved.

The process of feeding took at least 20 minutes.

There were a few slight color changes during the process. The animal remained more or less brown throughout. With Y and Ring. But toward

But toward the middle of the meal, the background color of the back became lighter. Quite yellowish. And apparently more strongly spotted (perhaps a trace of "real" freckle?). At the same time, there also was a trace of the water spot of complete Dice. But this faded out fairly soon.

When the animal finally swam over to sand and settled, it did not go sand-colored before burying.

Everything quiet 1:30 p.m. But there is one small (the hungry ind.?) resting on top sand. With complete carapace.

Buried again by 2:00 p.m.

Nothing more of interest in afternoon. All I can see is an occasional carapaced head peering out.

5:20 p.m. Poke one small ind. out of sand. With full carapace. Retreats very reluctantly and slowly. Only for a few cm. Arms dark at first. Then light yellowish brown (unspotted). Ind. settles on edge wood and sand. Sits.

The lights finally go off 6:10. The ind. that I had disturbed immediately goes back to sand, settles. But other inds. start to emerge immediately. One or two without carapaces. The rest with full carapaces. All or most inds. rest on surface for a few seconds or minutes after emerging. Then many of them start to swim and hunt actively. Some inds. lose carapaces, in patches, even before starting to swim. Does the species have an "anti-coagulant"? (It does have at least 2 types of secretory cells in the skin.)

Some inds. were buried so deep that they had to use powerful jets of water by the funnel in order to get out.

All inds. are in Dark or semi-Dark. Perhaps Dark-Freckle in some cases. Little or no Fin Stripes or Ring.

One small Eup catches Leander. The shrimp is not particularly large for its species, but it is substantial and probably difficult for the Eup. The Eup turns very Dark and jets ink twice after the capture. Begins to eat tail first while hanging in water. (Like the ind. this morning. Apparently prey is not taken down to substrate.)

Frank Stanton says that he saw 2 Leander taken a couple of nights ago. Both also tail first. (Probably because of antennae.)

The first inds. to emerge were all small. First large emerged 6:30 p.m.

(It was our impression, the night that we went fishing, that we caught most of the large inds. relatively late in the evening. Differential tanning certainly would reduce competition between old and young.

The animals seem to be avoiding one another without fighting.

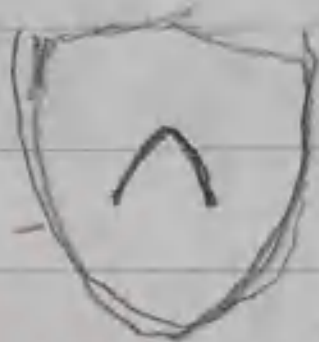
There are at least 13 inds. still alive.

After I write these notes, I go back and look again. Some animals are swimming actively, apparently hunting. Others are resting quietly on bottom (both sand and wood). Two very smalls are Dark. All the other inds. are lighter than they were earlier. Almost sand color (even on wood) some at least semi-freckled. Others not.

All inds. tend to Darken if I shine light on them steadily.

Two rather medium sized inds. have silver v-shaped markings on back. Front boundary of where the center spot of Dice would be if it were present (which it is not).

I have seen these marks before.



Perhaps they are only an internal organ showing through.

As far as I can tell,

none of the inds. has T

Good heavens! Return after writing the above, to find the two largest Eups in copula. (Of course, I did not preliminarily "courtship" or "solicitation" but it must have been brief - at least tonight.) One ind. is flat on ground and slightly behind. The other is above, tilted forward at an angle (and perhaps also skewed or tipped slightly on one side.) Top individual, presumably ♀, seems to be slightly larger than the bottom ind., presumably ♂.



← this may be slightly misleading. At first, the ♀ may have been less strongly tilted,



pressing down more heavily on the ♂. In any case, ♂'s eyes are just in front of ♀'s fins. (I think that fin shape is correct in this particular sketch.)

The ♂'s back, and what I can see of the top of his head, is covered by a uniform and intricate pattern. A fine reticulation of dark brown upon a cream or light yellow pattern. Looks rather like some reticulations of Octopus vulgaris.

(I could not see any textural components. Perhaps the skin was smooth.) The pattern could also be related to the PH of Sepioides.

The ♀ was much more variable. When first seen her head and back were a soft uniform dove gray. This is a resemblance to Sepia latimanus. With several added components. The extended arms were medium brownish (perhaps "Ind" ???) The whole rear edge of the body was defined by a sharp but rather narrow white border, which I will call "WTB", extending roughly from fin to fin.

Could this be related to the RL of Sepioides ??? At least one of her fins (the one that was upper because of the sideways tip) was beating madly. Perhaps a flutter.

Some changes set in which I would interpret as signs of hostility or disgust. Perhaps as a reaction to my light. Or perhaps a (natural) reaction to the ♂ as the copulation progresses. Some black appears on the back. Beginning at the border of the WTB. First appears briefly as fine lines, like the so-called "Zebra" of Sepia spp.  This quickly changes to pure black. A sort of "Black Tail Border" (BTB). Sharply defined against WTB. More smudged in front. The black expands, gradually and irregularly. Into a sort of Ring-like arrangement, with distinct traces of 2 (perhaps sometimes 3) longitudinal smudges or blurs toward rear. More or less comme ça  anterior spot. Also

Note this is not a Fin Stripe. It is on the back, not along the side

Fins are transparent throughout 3-stripe version has 1 central and 2 lateral stripes

Black toward rear can be even more extensive

COMMENT: The forms, although not the position, of the WTB and BTB are remarkably similar to the WB and BB of Sepioides. The resemblance is so close that it can hardly be coincidental. As I remember, the WB and BB also are associated with courtship and/or copulation. This would appear to be another case - like the DM's of Sepia officinalis and Octopus

vulgaris - of the same pattern appearing on different parts of the body in different species of different shapes.

At approximately the same time that the BTB developed, the top of the head turned brown again.

Whatever caused these changes in the ♀, I was sure that my light was not helping matters. So I started to turn it off at intervals. Twice the animals moved (10-20 cm.) in the dark. Still in copula each time I turned the light on again. Perhaps copulation is a mobile process in the wild?

As it continued, the arms of the ♀ gradually curled under. Perhaps manipulating the spermatophore. At same time the rear part of her body seemed to be lifted higher.



This may be only an approximation or guess work. I was looking at the animals from straight above.

Later still, the ♀ resumed a slanting posture as on p. 104. And her head went gray again. Possibly even her arms went gray. But the BTB remained. Sometimes weak, sometimes strong.

Any sideways skew of the ♀'s body which may have been present at the beginning of copulation disappeared after a few minutes.

The light of the flashlight produced some peculiar optical effects (reflections) which may have been slightly misleading; but I am fairly certain that the ♀ also showed two other patterns during the later stages of the copulation. A brilliant iridescent blue-green streak on at least one eyebrow for at least a few minutes. And a small silvery patch in the center of the BTB when it was extensive. (It is possible, however, that these patterns would have been inconspicuous in a less concentrated light beam.)

Toward the end of the copulation, the ♂ seemed to be slipping back, further behind the ♀.

Finally the 2 animals separated. Of course, when I had my light turned off for 1-2 mins. When I turned it back on again, I found the 2 animals still

ing on the substrate, sand, 30 cm. apart from one another. The ♀ was already in the usual pale sandy, slightly mottled, coloration. The ♂ was still in full Reticulate. This faded gradually over a period of 4-5 mins. (As in sepioides, the ♂ seemed to be ready to continue. It probably was only the behavior of the ♀ which turned him off.)

I began to watch the copulation at 7:10 p.m. The copulation finished around 7:35. It may well have been delayed by my use of the light. But the normal copulations of the species must still be much more prolonged than those of the Sepioteuthis spp.

ADDITIONS AND CORRECTIONS. I have had a chance to speak to Frank Stanton personally. It turns out that my account of the copulation that he witnessed on p. 99 (filtered through Reese) is wrong. The cop was not front to front. Instead, the animals were in much the same relative positions as the inds. observed tonight. But the lower ind. was grasping the upper ind. with 2 arms (tentacles?) The animals were spotted. But probably with the usual brown freckles (the brown could be described as reddish brown in some lights). Perhaps this copulation included (even) stronger hostile components than the one observed tonight.)